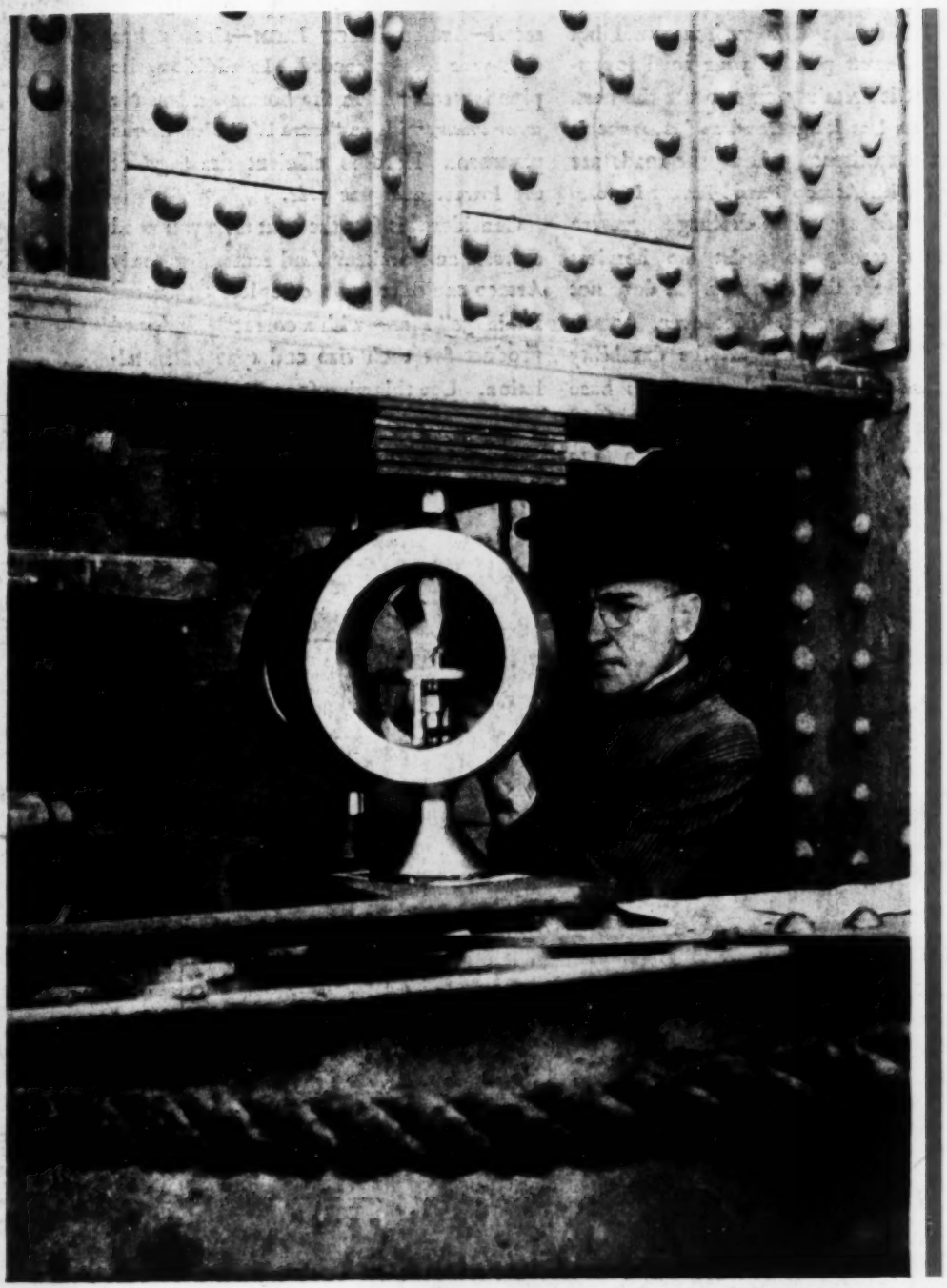
APR 1 1935

Engineering News-Record



WEIGHING IN . . . Proving rings, conventional calibrating devices for testing machines, being utilized to weigh the half-million-pound reactions of one of the new three-span continuous-truss bridges over the Cape Cod Canal

March 28, 1935

Express Highway in Newburyport

Sewer Linings to Resist Corrosion

Bridge Reactions by Proving Rings

John F. Stevens' Recollections—II

Current Research at Wisconsin

Supreme Court on Grade-Separations

Twenty-five Cents
Five Dollars per Year

McGraw-Hill
Publishing Company, Inc.

Your MAIN Roads Deserve

Armco Paved Invert Pipe

——and you'll find it costs less per year under other roads, too

GOOD drainage is such a small but important part of your road investment that it certainly pays to use the best. Pavements last longer and maintenance is kept at a minimum, when your roads are drained with Armco Paved Invert Pipe.

This modern, flexible drainage structure is amply strong to resist the heaviest loads and vibration of traffic. It does not break or pull apart. Moreover, Armco Paved Invert Pipe has all the durability your roads require—and more! Its base metal—Armco INGOT IRON—already has a 29-year service record. In addition, the pipe is protected in the bottom, *where the wear comes,* with an "extra life" bituminous pavement. Here is efficient drainage at the lowest cost per year.

Consider this fact the next time you need culverts and drains. And remember, only Armco can offer you a complete "Balanced Drainage" Plan—with a correctly designed product for each size and type of installation. Use this plan for true economy.

ARMCO CULVERT MANUFACTURERS ASSOCIATION
Middletown, Ohio

Armco Paved Invert Pipe being used in connection with widening a heavily traveled highway, U. S. 127.

ARMCO'S "BALANCED DRAINAGE" PLAN

FOR MAIN ROADS

(State Highways and Important County Routes)

Type of Installation	Product Recommended for Best Results
1 Small and medium size openings. (8 to 84 in.)	
a. Entrance Drains	Armco Corrugated Pipe
b. Cross Drains	Armco Paved Invert Pipe
2 Bridges and Large Culverts	Armco MULTI PLATE (Full-round or arches)
3 Subdrains	
a. Paralleling Road	Armco Perforated Pipe
b. Under Pavement	Armco Perforated Pipe (with Paved Invert)

FOR SECONDARY ROADS

(County and Township Roads)

Type of Installation	Product Recommended for Best Results
1 Small and medium size openings	
a. Normal Conditions	Armco Corrugated Pipe
b. For Steep Grades	Armco Paved Invert Pipe
c. Continuous Flow	Armco Paved Invert Pipe
d. Under High Fills	Armco Paved Invert Pipe
e. Diameters larger than 24 inches	Armco Paved Invert Pipe
2 Bridges and Large Drains	Armco MULTI PLATE (Full-round or arches)
3 Subdrains	Armco Perforated Pipe

ARMCO

★ **FOR TRUE ECONOMY** ★

make service conditions your guide

No Fear of Excess Profits

IN discussing the proposed emergency construction program, Walter Lippmann recently took a passing crack at "contractors' profits," rating them in a class with "Congressional pork barrels" and the unsavory prevailing wage propaganda.

To this writer there is nothing particularly terrifying about profits, whether for contractors or anyone else. As a matter of fact, he cannot just see how we can expect to have a business revival under an economy based on the profit system unless someone begins to make some profits.

But to those who may fear excessive contractors' profits in connection with emergency construction, the following is commended. It is an extract from a colloquy between Wright Patman, Representative from Texas, and Thomas H. MacDonald, chief of the Bureau of Public Roads, in the course of the latter's testimony before the House Committee on Roads.

Mr. Patman. Now, if we are going to pass a law and provide an enormous sum of money for the purpose of aiding the employment of a large number of people, we should safeguard that law and not permit unreasonable profits, should we not?

Mr. MacDonald. Yes. That would be more or less theoretical, though, as far as highway work is concerned.

Mr. Patman. Well, you stated a minute ago that it costs 30 percent more to do this work by force labor than by contract. Do you know how much profit the contractors made on the projects you gave in this comparison? Of course, that should be added to the 30 percent, which would make a difference.

Mr. MacDonald. The contractors' profit, as a general proposition, has been almost nonexistent ever since the depression began, and there is a considerable question in my mind whether we have paid fair prices.

All of which is somewhat more than an indication that competitive awards to private contractors are more economical than governmental day-labor in the conduct of highway construction. It should serve as an ample reassurance to those who may still fear that the public works program may be subject to exploitation through unreasonable profits to contractors.

Quite to the contrary, the government is in position today to hire the most experienced and competent construction talent at bargain prices. The use of the organized construction industry to carry out the emergency construction program not only will create widespread employment and help to stimulate the many industries that are dependent on construction; it will also guarantee to the taxpayers the largest possible return in public wealth for whatever expenditure they may make on the program.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 114, No. 13. Price 25c. per copy. Subscription, domestic, Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries, $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1935 by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d Street, New York; 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
WILLARD CHEVALIER, Vice-President
JAMES H. McGRAW, JR., Vice-Pres. and Treas.
B. R. PUTNAM, Secretary

Printed by The Schweinler Press, N. Y.

Table of Contents—See Page 21

COMPLETE LINES OF TIRES FOR EVERY CONSTRUCTION SERVICE AT LOWEST PRICES—GIVING LONG MILEAGE AND GREATEST ECONOMY

FIRESTONE pioneered the ship-by-truck movement in 1918, and ever since has consistently led in anticipating every requirement in the design and construction of truck and bus tires for every transportation condition. To accomplish this, Firestone has consistently followed the fundamental principle of its founder and active head, Harvey S. Firestone, "Always to find the way to build tires better than anyone else."

While there are many reasons why Firestone Tires are safer and more economical, there are two reasons that stand out above all others. One is Gum-Dipping; and the other is two extra layers of Gum-Dipped cords under the tread.

By Gum-Dipping, every strand in every cord is soaked in liquid rubber, preventing friction—adding extra strength and long mileage. By having two extra layers of Gum-Dipped cords placed between the tread and cord body, it is practical to use a tread with higher, more rugged shoulders and a deeper non-skid with flatter contour.

All this provides more rubber on the road, giving longer wear, greater traction and quicker stops. These two extra construction features are patented and used only in Firestone Tires. Take a forward step in maintaining schedules and reducing operating costs. Call on the Firestone Service Store or Firestone Service Dealer today.

Firestone
HIGH SPEED TYPE
Greatest tire ever built for all-round service.

Firestone
OLDFIELD TYPE
The tire that taught thrift to millions.

Firestone
SENTINEL TYPE
Volume production tire for light trucks.

Firestone
GROUND GRIP TYPE
Super traction tire for unimproved roads.

★ ★ ★ ★ ★ *Listen to the Voice of Firestone—featuring Richard Crooks, Gladys Swarthout, or Nelson Eddy—every Monday night over N.B.C.—WEAF Network . . . . . A Five Star Program*

AUTO SUPPLIES FOR TRUCKS AND BUSES

FIRESTONE TRUCK TYPE BATTERIES

FIRESTONE HEAVY DUTY SPARK PLUGS

For quick starts and longer mileage.

FIRESTONE BRAKE BLOCKS and HEAVY DUTY LINING

For better braking control.

FIRESTONE FAN BELTS

FIRESTONE RADIATOR HOSE

Firestone

© 1935, F. T. & R. Co.

ENGINEERING NEWS-RECORD

Editorial Staff
V. T. Boughton
W. G. Bowman
C. S. Hill
Chicago
W. W. De Berard

McGraw-Hill Publishing Co., Inc. Editorial and Publishing Offices: 330 West 42d St., New York

F. E. Schmitt, *Editor* Willard Chevalier, *Vice-President*

Editorial Staff
F. W. Herring
H. W. Richardson
J. I. Ballard
San Francisco
N. A. Bowers

CONTENTS FOR MARCH 28, 1935

Volume 114 Number 13 Copyright 1935

Relocation of Famous Newburyport Turnpike 439

Corrosion Tests for Sewer Lining Materials.. 444

Proving Rings Weight Bridge Reactions..... 446
BY C. M. SPOFFORD and C. H. GIBBONS

An Engineer's Recollections of the C.P.R.—II 450
BY JOHN F. STEVENS

Engineering in Foreign Countries—III..... 452

Current Research, University of Wisconsin.. 455

Supreme Court Decision on Grade-Separations 458

Review of Recent Engineering Literature.... 460

Letters to the Editor..... 461

Current News 464

Unit Prices 470

New Equipment 472

In the News:

On Saturday the Senate passed the Administration's $4,880,000,000 work-relief bill, and it will now return through conference committee to the House for reconciliation of changes which have been introduced since its speedy passage by the lower branch.

A Major railroad-improvement project was completed when the Newark, N. J., station was placed in service March 24 by the Pennsylvania Railroad Co. The work also includes a rapid-transit terminal built jointly by the railroad, the city and the Public Service Coordinated Transport.

The New Chief Engineer of the Los Angeles County Flood Control District is already in trouble with the county supervisors over the appointment of his key assistants.

Bids Have Been Called for April 30 on the $3,000,000 low-cost housing project of the PWA in Indianapolis, to consist of 23 apartment buildings and 96 row houses.

Waco, Tex., has been held to be infringing on the patents of Activated Sludge, Inc., in the operation of its sewage-disposal plant, according to a federal court decision signed March 20.

Indictments charging conspiracy to defraud were brought by a special grand jury in the District of Columbia against seven persons involved in the $4,850,000 PWA irrigation project in Willacy County, Tex. The charges center around an alleged change in specifications which would favor a particular material in the building of a pipe line.

Work on the Bureau of Reclamation buildings at the Grand Coulee project has advanced far enough to transfer engineering headquarters from Almira to the site.

The Arkansas State Supreme Court has ruled that the city of Fort Smith has the right to enter into a contract with the PWA to sell $1,270,000 of revenue bonds to improve the waterworks system.

Presidential Approval has been given to the highway contractors code (2-C) of the general construction code, providing a basic maximum 40-hour week and a 40c. minimum wage. It became effective March 26.

In This Issue:

Highways Through Cities, long neglected because state highway funds stopped at the city limits, have been greatly improved during the past two years with funds provided through the NIRA. One of the outstanding jobs is the new cutoff at Newburyport, Mass., of express highway character and costing about $1,000,000 for its 6,600-ft. length. The article describes the development, including slab and bridge design.

Highly Septic Sewage causes a serious corrosive-gas problem in Los Angeles sewers. Extensive experiments have indicated tentatively that sulphur-silicate spray coats or a lining of sulphur-silicate blocks fused together at the joints furnish the best lining.

Adjustment of continuous-truss bridge reactions forms a part of the erection procedure on such structures. A new method of weighing such reactions utilizes the well-known elastic loops or proving rings developed to calibrate testing machines. An article reviews the general subject of continuous bridge construction and tells of the use of proving rings on the Little Bay bridge in New Hampshire and on the Cape Cod Canal bridges in Massachusetts.

Continuing a series of articles on current research in the various colleges, Dean F. E. Turneaure outlines the extensive work being carried on at the University of Wisconsin in the fields of strength of materials, highways and hydraulics.

John F. Stevens' second article in his series on "An Engineer's Recollections" is concerned with the extension of the Canadian Pacific Railway's surveys into the Canadian Rockies in 1883.

The recent Supreme Court decision holding that states cannot require railroads to pay a large part of the costs of a grade-separation built primarily to facilitate motor-vehicle travel is abstracted in a two-page article in this issue.

Coming Articles:

An Outstanding railroad construction job last year was the driving of the large double-track P.R.R. Tunnel through treacherous ground in Baltimore. Its size alone—36 ft. in diameter—imposed many driving difficulties. But the existence of a heavily used, 61-year-old tunnel alongside, with a faulty brick lining threatening serious trouble in case of loss of ground into the new bore, demanded more than usual caution and tunneling skill. The successful completion of this difficult tunnel job with the use of shield-driven side drifts as the foundations for a huge roof shield that left a protecting support of cast-iron rings in its wake is an engineering and construction achievement of note. How it was done will be told in the issue of April 11.

VISIBLE—FROM ANY ANGLE!

Atlas White Traffic Markers show up, clear and distinct, even from 1500 feet altitude.

YOU'RE in a plane, 1500 feet up, as you look down on Wilshire Boulevard, Los Angeles, in the view at the left. See how sharp and well-defined and *white* those concrete traffic markers are! You can't miss seeing them. And the drivers of those cars down there see them lots more clearly.

Those markers, when this picture was taken (and you see it just as the camera caught it), were just a little more than six months old. Six months of traffic hasn't dimmed them or dirtied them. Six months of weathering hasn't faded them. And six years from now these white concrete markers will be guiding traffic just as efficiently —because they are *built* white and they *stay* white.

Atlas White traffic markers are built *into* the pavement. They are made of solid white concrete. They have a dense, solid, hard, white surface. Once installed, they never wear away, they never fade out, they never need replacement. They last as long as the pavement lasts. Their first cost is the last cost. They are *indelibly* white.

Write for complete information on these effective, economical, white concrete traffic markers to

UNIVERSAL ATLAS CEMENT CO.
208 South LaSalle Street, Chicago
(*United States Steel Corporation Subsidiary*)

The Atlas White Traffic Markers that are so clearly visible in the view at the left were installed on Wilshire Boulevard, Los Angeles, by the Griffith Co. of Los Angeles, under the supervision of the City Engineer.

185

ATLAS WHITE TRAFFIC MARKERS

Made with Atlas White Portland Cement—Plain or Waterproofed

ENGINEERING NEWS-RECORD

March 28, 1935

FIG. 1—IN A 200-FT. RIGHT-OF-WAY formerly occupied by old buildings, the new express highway through Newburyport, Mass., eliminates a former circuitous route through crowded streets. View from High St. north toward river bridge.

Highway Through City Relocated in New 200-Ft. Right-of-Way

Road through Newburyport, Mass., placed in blocks formerly occupied by old buildings—Divided roadways, rigid-frame and continuous-girder bridges, cut, fill and retaining-wall work included in $1,000,000 job

THE FAMOUS Newburyport Turnpike, principal route north from Boston to Portsmouth and Portland, crosses the Merrimack River at the city of Newburyport, Mass. Between the Newbury-Newburyport city line and the bridge, traffic has had to follow a circuitous route over narrow and crowded streets. The need for a relocated cutoff route at this point has long been recognized, but it was not until the National Industrial Recovery Act made federal money available for routes through cities that such a project could be carried out. The work, which the Massachusetts department of public works has recently completed, constitutes one of the most remarkable highway-relocation jobs in the country. Some 6,600 ft. long, the new route involves extensive cut-and-fill operations, with a large amount of retaining-wall construction, two 23½ to 30-ft. roadways divided by a center island, and three grade-separations in which interesting rigid-frame and continuous-girder structures are used. In addition, what is perhaps the most unusual characteristic of the project is its location in a special right-of-way 200 ft. wide between two existing streets, which are retained as marginal routes for local traffic. Preparation of this right-of-way required removal of many old buildings, an operation which was essentially slum clearance in character.

The location of the cutoff in relation to the old route through the city is shown in the sketch map, Fig. 2. Ordinarily such a cutoff as this would be located so as to bypass the city entirely. Two physical conditions made such a plan impracticable in this case. The bridge over the river fixed the north terminus of the cutoff, while the tracks of the Boston & Maine Railroad constituted a western boundary beyond which it was impracticable to locate the road. As built, the road branches from the old location at a traffic circle just inside the city line, runs west and north about 1,900 ft. to the railroad, and then parallels the railroad to the river. It is the last 2,400 ft. of new cutoff road that includes the expensive property damage and building demolition.

Grading operations were required throughout the full mile and a quarter length of the cutoff. From station 1 at the south end of the work, a fill about 6 ft. high extends to station 12, about 1,200 ft. From station 12 to station 20 is a cut, gradually increasing in depth up to about 20 ft. at station 20. From station 20 to about station 40 the highway is mostly on fill, varying from 10

to 20 ft. in height. At station 40, about where the extensive building demolition began, the new route is in cut between retaining walls, passing under High and Washington Sts., which are carried over on steel and concrete rigid-frame bridges, respectively; the road finally comes to grade at Pleasant St., station 55. Beginning at the north side of Pleasant St. at about station 56, the new road rises on a fill between retaining walls to a viaduct structure over Merrimac St. and finally comes down on another fill between retaining walls to grade at the bridge head, station 66.

Throughout the length of the work, all cross-streets are blocked off with the exception of those at the three grade-separation locations and at Pleasant St. The latter is an intersection at grade, but traffic will be so regulated that it can only turn into or off the cutoff and not cross it. North of High St., the right-of-way is between Summer and Winter Sts., the existing thoroughfares. These streets, located above and just outside the concrete retaining wall of the new cut, have been reconstructed as marginal ways for local traffic.

Within the new 200-ft. right-of-way, the new highway occupies only about 65 ft. Strips on either side, some 40 ft. wide, slope upward to the base of the retaining walls, and will be planted with grass and shrubs. The center strip between the roadways also will be developed as a grass plot in some sections, while in others a gravel surface is provided.

Pavement

At the beginning of the project, where it branches from the old road (Fig. 2), a traffic circle was constructed having an inside radius of 100 ft. The circle has a pavement width of 50 ft., the inner lane being 7-in. bituminous macadam asphalt 14 ft. wide, around which were constructed three 12-ft. lanes of 8-in. reinforced concrete.

From the traffic circle to Railroad Ave., a distance of 3,700 ft., the pavement consists of two 30-ft., 8-in. reinforced-concrete roadways, each roadway made up of three 10-ft. lanes. The two roadways are separated from a center strip 8 ft. wide by a 1-ft. bituminous concrete shoulder. The center strip through this section is to be loamed and seeded.

For the remaining distance to the Merrimack River the pavement consists of two 22½-ft., 8-in., reinforced-concrete roadways, each roadway made up of two 10-ft. and one 2½-ft. lanes, the 2½-ft. lane being on the outside. The two roadways are separated from a center strip 5 ft. wide by a 1-ft. bituminous concrete shoulder. The center strip through this section is surfaced with concrete, which provides a walk and safety island for workmen. Granite curbing is used throughout, both for the center strip and for sidewalks.

Gravel walks are provided on both sides from the beginning of the project to Railroad Ave. Elsewhere walks are provided on ramps, connecting roadways and on the marginal roadways from High St. to the river.

Gravel was used as foundation, 12 in. in depth throughout. Between Vermont St. and the river an extensive new drainage system, consisting of vitrified clay and cast-iron pipe, has been installed, to carry all stormwater direct to the river.

Retaining walls

Retaining walls (Fig. 3) are in general of gravity section and of conventional design. An exception occurs in a 200-ft. length south of High St., where because of the close proximity of houses to the top of the cut a reinforced-concrete L-wall, with a toe projecting in front of the wall and under the roadway, was constructed. This particular type of wall required the least amount of excavation under the houses, many of which were in rather poor condition. These walls have a maximum height of 28 ft., and the base is 15 ft. wide with a 9-ft. projecting toe. During construction, steel columns supporting the buildings were embedded in the footings of these walls, and the vertical walls were poured around them, the columns being left in place. As the face of these walls was to be only 18 in. from the edge of travel, refuge bays were built into the walls about 34 ft. apart.

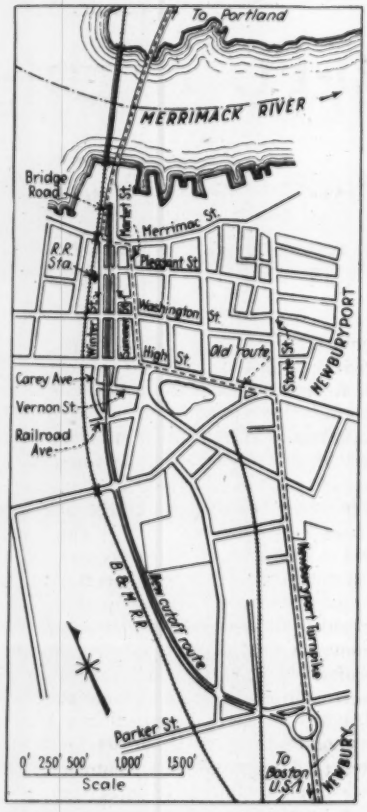


FIG. 2—NEWBURYPORT CUTOFF and former route that turnpike traffic had to follow through the city.

Rigid-frame structures

Two of the grade-separations, respectively at High and Washington Sts., are of rigid-frame type. In all essential dimensions, in design loading (H-20) and in final appearance these two structures are identical. Actually the High St. bridge is a steel rigid frame, while the one at Washington St. is of concrete. Steel was chosen for the busy High St. crossing because it was felt that a steel-frame structure could be built and opened to traffic in the shortest possible time. Actually the detour provided proved so satisfactory that work was not pushed, and the concrete bridge at Washington St. was opened for travel before the steel frame.

The problem at both locations was to carry an important street over the new highway (which was depressed) by excavating only enough existing ground to get the required clearance under the new structure. Accordingly the following fundamental requirements were indicated: (*a*) a minimum depth of girder; (*b*) continuity of girder and support, to permit less depth at the middle of the span than at the ends; and (*c*) thin abutments requiring a minimum width of trench excavation.

The clear span required in both cases was 55 ft. The width of the High St. bridge was made such as to provide for a 42-ft. roadway flanked on one side by a 10-ft. sidewalk and on the other by a 14-ft. sidewalk. In the case of the Washington St. bridge, a width to accommodate a 40-ft. roadway and two 8-ft. sidewalks was needed.

The High St. bridge, as stated, is a steel-frame structure. It includes eight parallel frames spanning across the new road and providing a vertical clearance of 14 ft. The design differs from the usual arrangement of steel rigid-frame bridges in that a horizontal joint is used at the level of the bottom flange in the girders. In this type of joint the compression is cared for by faced ends on the posts and stiffeners on the girder webs, while the tension connection is made by means of vertical plates shop-riveted to the back of the posts and field-riveted to the ends of the girders. Triangular reinforcing plates across the ends of the girders resist the diagonal shear in the web at this point.

The make-up of these frames is shown in Fig. 5. The girders are 1 ft. 9 in. deep back to back of angles at the center line and 3 ft. 1¾ in. at the end. The bridge carries a 9-in. reinforced-concrete slab, and the posts are embedded in the concrete of the abutment wall. Architectural detail is added in the form of bush-hammered concrete facing and fluted-surface concrete pilasters at the abutments.

Inasmuch as the steel girders are designed as beams fixed at the ends to

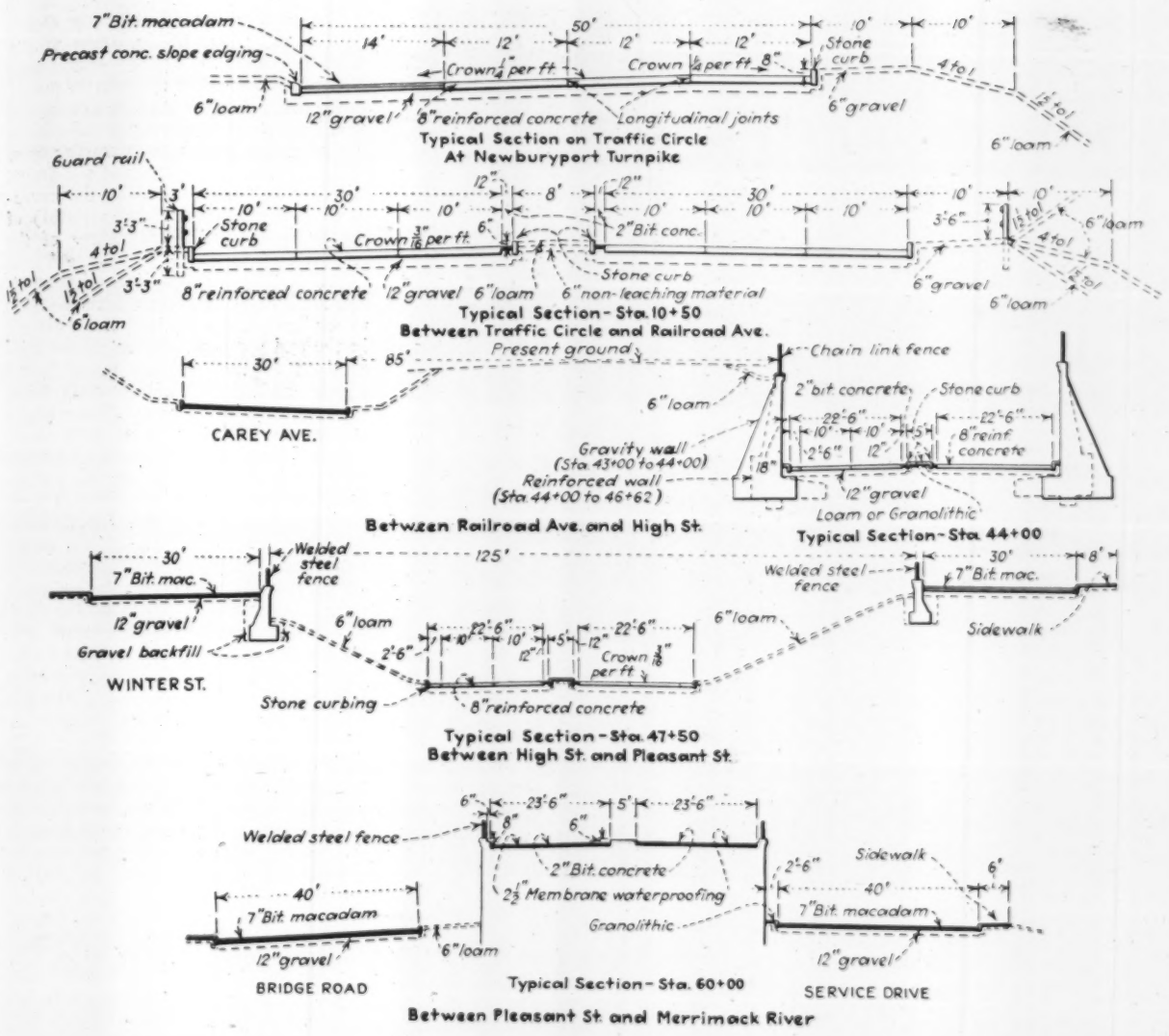


FIG. 3—TYPICAL SECTIONS of Newburyport cutoff vary from fill to retaining-wall cut to viaduct along its 6,600 ft. length.

stiff posts resting upon hinged shoes, special precautions were necessary during erection. A falsework tower was erected beneath the center of the girders as a support and to permit adjusting the height, to bring the top flanges straight. The distance between anchorbolts at opposite ends of each frame had to be accurately determined by a steel tape, with allowance for temperature variations from the 50 deg. F. temperature assumed in the design. To permit a perfect contact between the girders and the post, some leeway was left in the anchorbolt holes in the shoes, to allow movement of the post. After the post-girder connection was bolted, the shoes were concreted in and the post-girder connection was riveted. The middle falsework support was then released. No dead load other than the weight of the steel was allowed on the bridge until the posts were concreted to their tops and all abutment backfill placed.

The concrete rigid-frame bridge which carries Washington St. over the new highway is of barrel type. It has a 55-ft. clear span and a barrel width of 59 ft. 8 in. The frame from footing to footing required about 600 cu.yd. of concrete and 100,000 lb. of reinforcing steel, or 165 lb. per cu.yd. The foundations consist of a slab about 3 ft. 9 in. thick, 9 ft. wide, and as long as the bridge is wide—namely, about 60 ft. The barrel is 1 ft. 8 in. thick at the center of the span and 4 ft. thick at the end where it connects to the vertical post. Reinforcing details for this structure are shown in Fig. 5. In constructing this bridge the footings and vertical walls were poured first for their entire width. The top of the frame was then placed in one pour, a mixer being set up on the street in back of each abutment, with work progressing from either end.

A cost comparison between the concrete and the steel rigid frames shows that the cost per square foot, exclusive of wing walls, is $5.50 for the concrete frame and $7.30 for the steel frame.

Continuous steel girders

At Merrimac St. the new highway is carried over on a three-span, continuous-steel-girder structure flanked by reinforced-concrete viaduct approaches—four 32-ft. spans at the south end and eight 32-ft. spans at the north end. The space beneath these concrete viaducts is enclosed by concrete walls and windows on both the east and west faces and will be used as a state garage and warehouse.

The requirements of the problem for the Merrimac St. overpass dictated: (1) a deck structure with no parts projecting above the floor; (2) a minimum depth of structure, with 14-ft. clearance over any part of the street surface; and (3) on account of curves in Merrimac St. each side of the viaduct, a minimum of obstruction to lines of sight in the street. This last requirement precluded the use of abutments at the street lines,

FIG. 4—CANTILEVER RETAINING WALL south of High St., made necessary because of the close proximity of houses to the rim of the right-of-way cut. Refuge bays are provided for pedestrians.

and indicated a three-span structure. The second suggested the advisability of continuity; reduced girder depth would also be helped by the use of a double middle girder instead of a heavier single girder.

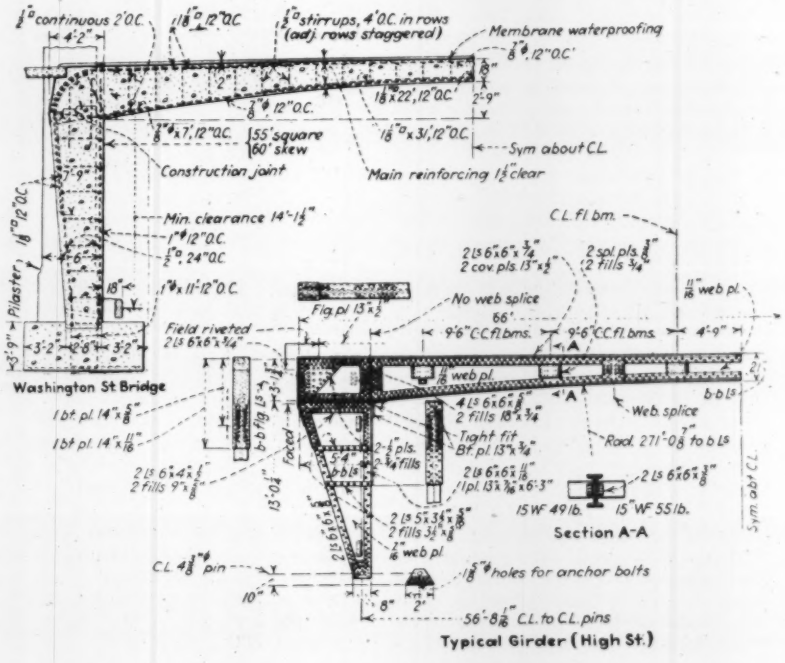
As designed and built, a center span of 77 ft. provides space for Merrimac St. and a sidewalk on either side, while the side spans are 32 ft. long. There are four lines of girders (Fig. 6) resting on two steel H-section column bents and two concrete abutments. In effect, the bridge consists of two structures 25 ft. 9 in. wide separated by a 3-ft. 2-in. space at the center. This 3-ft. 2-in. space, between the two center girders, constitutes the island separating the two roadways. The two columns supporting these girders are joined by double-diagonal bracing of $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{5}{16}$-in. angles. As an architectural expedient, to give an appearance of more bulk, the steel columns are encased in a rectangular box made up of two 12-in. channels and two 20-in. plates. The bridge is on a slight skew, but all floor beams are framed square with the girders and spaced 8 ft. apart in the side spans and 9 ft. $7\frac{1}{4}$ in. in the center span. The lateral x-bracing consists of single 4x4x$\frac{5}{16}$-in. angles in the plane of the bottom flanges of the floor beams.

Continuity on the structure is not achieved by making the girders in one piece over the columns but by carrying the columns to the tops of the girders and providing continuity through the columns. The ends of the girders butting against the columns are faced along the web connection angles and at the top and bottom flange angles. Compression is carried through the column from the bottom flange of the girders by means of stiffeners on the column webs consisting of two angles with their outstanding legs opposite the girder flanges. Tension at the top is resisted by a strap splice over the top of the column, tying the center and side-span girders together. The posts were designed as fixed at the top and hinged at the bottom. Allowance was made for bending stresses due to temperature changes and longitudinal force, but on account of the great difference in the moments of inertia in girder and post the latter was not considered as adding rigidity to the girder.

The girders are 56 in. deep at the center and about 66 in. deep at the column supports. The center-span girders are spliced at the quarter points, while the side span girders are in one piece. The end supports for the girders are on expansion bearings consisting of sliding plates. The details of the design were greatly complicated by the curvatures (both horizontal and vertical) of the overpass and by the skew of the crossing.

In erecting the structure, all columns and the bracing and struts between them were placed first, after which the girders in the end spans were erected, the connections to the columns being bolted tightly and the abutment ends being set on 10-ton jack screws. Floor beams and bracing of the end spans were placed next, after which the center-span girders were swung into place on the column shelf angles. With the girders temporarily supported in this position, the floor beams and bracing of the center span were erected. Then, by means of the jacks at the abutments, the end spans were raised until all parts of the faced girder ends were in close contact with the columns. Splice plates and angles were then applied and securely riveted, followed by riveting of the girder-web connections to the columns. Finally the jacks were released and the bearing plates in the abutments were adjusted by means of wedges. When the adjustment had been made, so as to secure firm contact without excessive load on the bearing plates, the wedges were removed and the bearing plates grouted.

FIG. 5—TWO RIGID-FRAME BRIDGES, one in concrete and the other in steel, carry important cross-streets over the Newburyport cutoff. Concrete pilasters, fascias and wing walls are used on the steel-frame bridge, so that both bridges are alike in appearance.



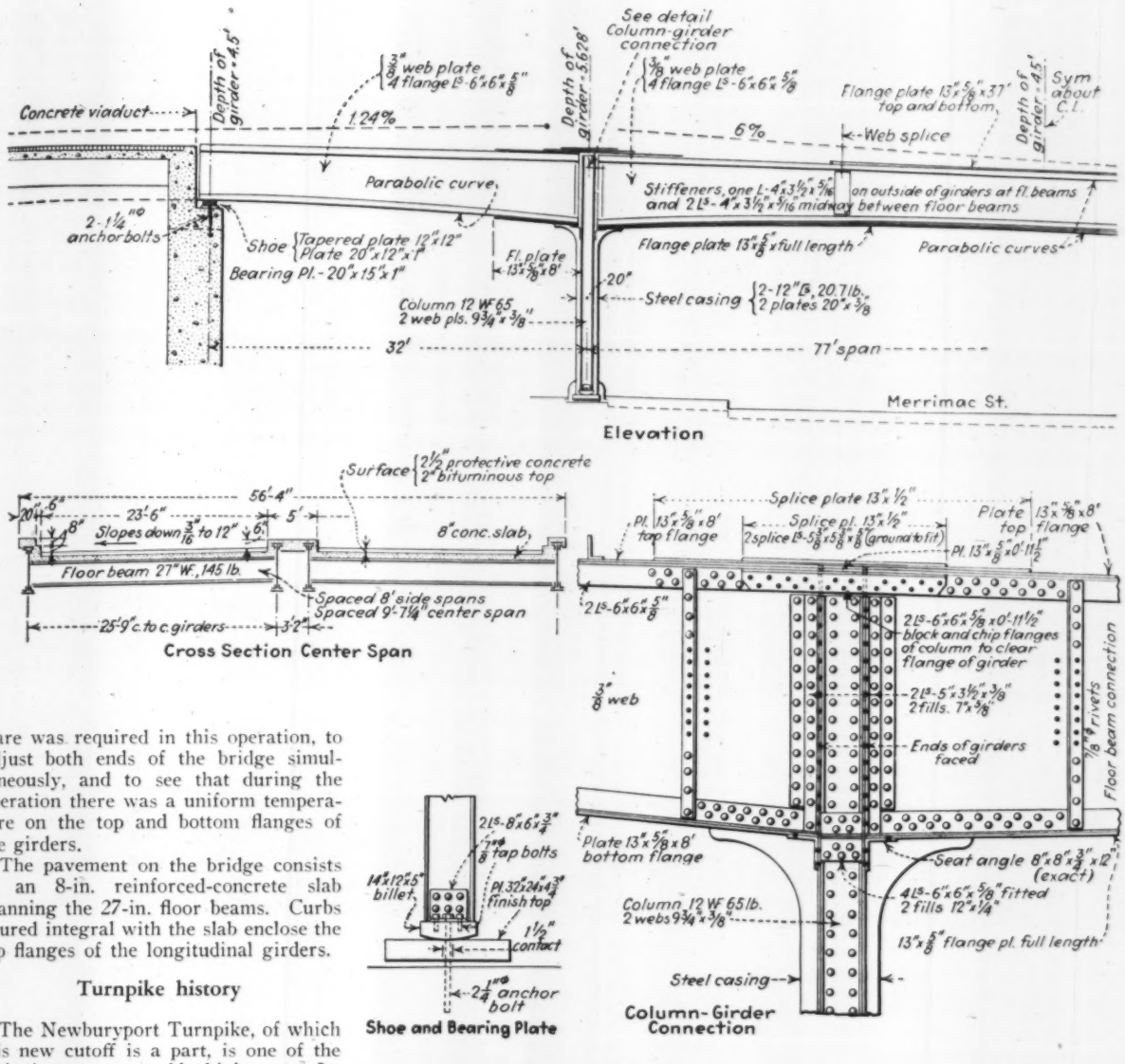

Concrete viaduct
Depth of girder = 4.5'
1.24%
3/8" web plate
4 flange L's - 6"x6"x 5/8"
Depth of girder = 5.62'
See detail Column-girder connection
3/8" web plate
4 flange L's - 6"x6"x 5/8"
6%
Flange plate 13"x 5/8"x 37' top and bottom
Web splice
Depth of girder = 4.5'
Sym about C.L.
Parabolic curve
Stiffeners, one L - 4"x 3 1/2"x 5/16 on outside of girders at fl. beams and 2 L's - 4"x 3 1/2"x 5/16 midway between floor beams
2 - 1 1/4" ø anchor bolts
Shoe {Tapered plate 12"x12" Plate 20"x12"x1"
Bearing Pl. - 20"x15"x1"
Fl. plate 13"x 5/8"x8'
Flange plate 13"x 5/8"x full length
Parabolic curves
20"
Steel casing {2 - 12" L's, 20.7 lb. 2 plates 20"x 3/8
Column 12 WF 65 2 web pls. 9 3/4"x 3/8"
32'
77' span
Merrimac St.
Elevation
Surface {2 1/2" protective concrete 2" bituminous top
56'-4"
20"
6"
23'-6"
5'
8"
Slopes down 3/16" to 12"
6"
8" conc. slab
Floor beam 27" WF, 145 lb.
Spaced 8' side spans
Spaced 9'-7 1/4" center span
25'-9" c. to c. girders
3'-2"
Cross Section Center Span
Splice plate 13"x 1/2"
Pl. 13"x 3/8"x 8' top flange
Splice pl. 13"x 1/2"
2 splice L's - 5"x 3 1/2"x 5/8" (ground to fit)
Plate top flange 13"x 5/8"x 8'
Pl. 13"x 5/8"x 0'-11 1/2"
2 L's - 6"x6"x 5/8"
2 L's - 6"x6"x 5/8"x 0'-11 1/2" block and chip flanges of column to clear flange of girder
3/8" web
2 L's - 5"x 3 1/2"x 3/8" 2 fills. 7"x 3/8"
Ends of girders faced
7/8" ø rivets
Floor beam connection
2 L's - 8"x6"x 3/4"
7/8" ø tap bolts
14" 12.25" billet
Pl. 32"x24"x 4 3/4" finish top
1 1/2" contact
2 1/4" ø anchor bolt
Shoe and Bearing Plate
Plate 13"x 5/8"x 8' bottom flange
Seat angle 8"x8"x 3/4"x12" (exact)
Column 12 WF 65 lb. 2 webs 9 3/4"x 3/8"
4 L's - 6"x6"x 5/8" fitted 2 fills 12"x 1/4"
13"x 5/8" flange pl. full length
Steel casing
Column-Girder Connection

FIG. 6—CONTINUITY of steel girders over three spans on Merrimac St., overpass achieved by carrying stresses through steel column supports that rise from foundations to roadway level. Double girder along center line permits shallow deck construction.

Care was required in this operation, to adjust both ends of the bridge simultaneously, and to see that during the operation there was a uniform temperature on the top and bottom flanges of the girders.

The pavement on the bridge consists of an 8-in. reinforced-concrete slab spanning the 27-in. floor beams. Curbs poured integral with the slab enclose the top flanges of the longitudinal girders.

Turnpike history

The Newburyport Turnpike, of which this new cutoff is a part, is one of the nation's most venerable highways. Its beginnings date back to the formation in 1803 of the Newburyport Turnpike Corp., which sold 995 shares of stock for about $420 each, for the purpose of building a road from the head of State St. in Newburyport to the Chelsea Bridge in Boston "as nearly in a straight line as possible." Some 25 miles of route south of Newburyport were opened in the spring of 1805, and gradually the rest of the road was put in service. For some 35 years this toll road was in operation. Then, according to Frederic J. Wood in his "Turnpikes of New England," it received a "mortal thrust from railroad competition. In 1840 the Eastern Railroad was completed to Newburyport, and the turnpike in that town and in Newbury lasted but seven years longer. The portion in Rowley, Ipswich, Topsfield, Danvers and Peabody became free in April, 1849, and in Lynnfield and Saugus in the same month of 1852, in which year the Middlesex section also became a public road, and the entire Newburyport Turnpike was free from toll."

The next half century of its existence was apparently a period of neglect. As recently as 1907 the Massachusetts highway commission reported that the road is "improperly laid out, the grades are excessive, the population along it is sparse, the villages on either side are provided with other roads better laid out, and there appears to be no reason why it should be a state road."

Shortly after, however, the commission changed its mind and, beginning about 1910, the road was progressively widened to a minimum of 18 ft., with gravel surface on 26 miles by 1916, when the average summer season traffic averaged 800 cars a day. The route was gradually becoming a major highway, and between the years 1916 and 1921 the pike was made a state highway and an 18-ft. concrete and macadam pavement was constructed for its full length. Between 1928 and 1930 the pike was widened its entire length to a 30-ft. and in some places to a 40-ft. width. The appropriations for this work amounted to about $1,200,000. The average daily traffic count in August, 1933, at the Boston end of the pike was 14,600 cars and at the Newburyport end 12,000 cars.

At the present time, according to A. W. Dean, chief engineer of the state department of public works, "There is much agitation and some tentative plans for the widening of the pike so that it may be constructed with two 30-ft. roadways, with a 10-ft. separating strip between. These plans also call for the elimination of all the major highway crossings similar to the work done on the Worcester Turnpike."

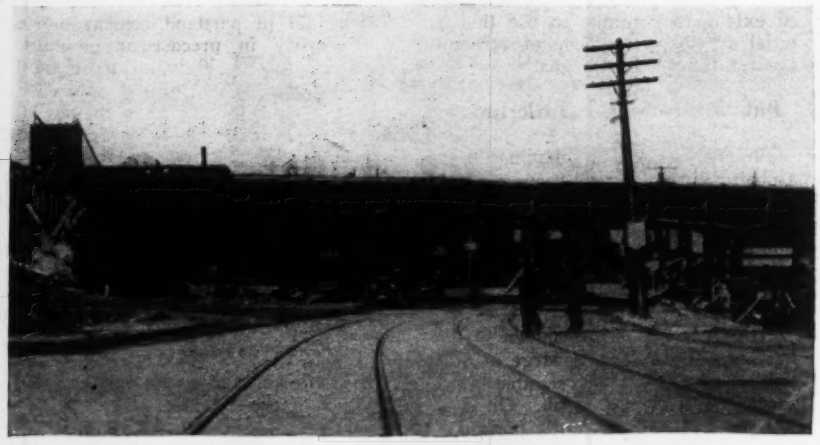


FIG. 7—THREE-SPAN, continuous-steel-girder bridge carrying Newburyport cutoff permits unobstructed lines of sight along Merrimac St., which passes under the structure on a curve.

The Newburyport cutoff was built by the Massachusetts department of public works, A. W. Dean, chief engineer; G. E. Harkness, bridge engineer, and J. E. Lawrence, district engineer. The steel rigid-frame bridge at High St. and the continuous-girder bridge at Merrimac St. were designed by J. R. Worcester & Co., consulting engineers, Boston. All other structures were designed by the state bridge department. The contractor for the main highway sections and the High and Washington St. bridges was the Geo. A. Fuller Co., Boston (bid $401,486); and for the Merrimac St. bridge and viaduct construction, Arute Bros., New Britain, Conn. (bid $120,590).

Sewer-Lining Materials Tested for Corrosion Resistance

Highly septic sewage in long sewer system at Los Angeles creates serious gas problems—Many tests show few materials have necessary resistant qualities—Molten sulphur silicate gives promising results

By H. G. Smith
Engineer of Sewer Design, Bureau of Engineering, Los Angeles, Calif.

SEVERE gas conditions are to be expected in the lower portions of a sewer system totaling 2,900 miles in length with direct flows ranging up to 45 miles long, which are the approximate figures on the Los Angeles system. For many years there has been ample evidence of the serious nature of attack on sewer linings of this city by acid combinations of hydrogen sulphide gas. As a result, particularly in the last six or eight years, experiments constantly have been under way to determine how materials used in the construction of trunk sewers can be protected from these attacks. No discovery has been made of ideal materials nor of methods that can be offered with unqualified recommendations, although the use of fused sulphur silicate seems to hold great promise. However, in the course of experience with the problem there have been observations which may be useful elsewhere. Some of these are set forth in the following paragraphs.

Numerous synthetic tests have been made in the city's laboratory, more particularly in connection with metals and cement mixtures. In a majority of cases, however, a synthetic test does not satisfactorily prove the ability of a material to withstand service conditions, and it has become the practice to regard conclusions on synthetic tests as only tentative, at least until a material has been tried out in actual service in the sewers for a period of years.

Many tests in sewers

In the laboratory and in the sewers tests have been made in recent years on about 150 specimens or samples of various products purporting to prevent concrete, brick mortar joints or metalwork from being attacked by hydrogen sulphide gas or by the acid combinations resultant therefrom. Some of these samples contain a bituminous or asphaltic base or are almost wholly composed of these materials. Others are certain cements in combination with clay, ashes or wood fiber. Also there have been tests of patented combinations which the department did not attempt to analyze. Inventors or manufacturers of the materials submitted for tests almost invariably were willing to guarantee them, although usually there was no conception of the intensive conditions to which their products would be subjected.

Out of the long list of these materials subjected to tests not more than six were able to resist comparatively moderate sewer-gas conditions for a period of years. Only two did not show indications of breaking down under the most intensive gas action. These two are both comparatively new types of heavy tile liner blocks made up of a combination of special clays and a compound of sulphur silicate with ingredients added to promote fluidity between the maximum and minimum temperatures used while pouring. Of this latter material there are a number of brands on the market, each using special combinations and methods of manufacture.

The best results thus far in resisting the most intensive gas conditions in the trunk sewers have been obtained by using the clay liners mentioned in the foregoing or hard-burned wire-cut brick able to show less than 10 per cent absorption. Where these liners or bricks of the qualities mentioned have been placed with poured sulphur-silicate joints, no indications of deterioration whatsoever have been observed in a period of more than three years. Individual test specimens placed in the sewer prior to these three-year-old installations still retain their original integrity.

Seeking a protection for Gunite

An important protection problem now before the city has arisen in the repair work to be done on the Central Outfall Sewer built about 32 years ago. This structure is about 10 miles long and ranges from 4.5 to 6 ft. in diameter. A considerable portion of it was built in tunnel, at some points 90 ft. below the surface. The sewer is semi-circular in section and was constructed of two and three rings of common brick laid in ordinary cement mortar. Two years ago extensive repairs in certain sections were necessary. These were made by removing all loose material, washing out the sewer with a high-pressure stream of air and water, and building up the void areas, which occurred almost exclusively in the arch, by an application of Gunite ranging from 2 to 5 in. in thickness.

Although this sewer is not used for sanitary flow at present, it is only a matter of time before that will be necessary, and thus it is essential that meantime the Gunite surface be protected

from the gas conditions that may be expected later. A tile lining undoubtedly would be effective, but it would have the serious objections of excessive cost and appreciable reduction in the amount of sectional area.

In the particular case of the Central Outfall Sewer an ideal solution would seem to be some form of spray coating, if such were available, because the time of application and the necessary cost would be less than for other forms of lining and there would be no material reduction in area. The use of a spray coating of sulphur silicate is being considered.

Sulphur silicate coatings

In recent years intensive experimental work has been done principally by two Los Angeles companies, with sulphur silicate sprayed in a molten state over concrete surfaces. There has been difficulty in perfecting apparatus of commercial size, which retains the proper nozzle temperatures and control. However, it is believed that this is only a matter of properly combining electrical and mechanical equipment, and a satisfactory solution is expected—if it is not, in fact, already developed. By these methods a uniform covering for the concrete is obtained, of thicknesses from 1/32 to 1/16 in.

With the exception of tests on small areas the only applications in service have been on the wet well of the Terminal Way pumping plant and on the walls and ceiling of a detritus tank at the head of the San Pedro siphon. Severe gas conditions are not expected at these locations because the sewage will be comparatively fresh. Neither of these structures, however, has as yet been placed in operation.

There seems to be no difficulty in meeting the requirement that the sprayed coating of sulphur silicate shall be of uniform thickness, free from pinholes, bubbles, blemishes or imperfections. At least, no such defects have been found by inspectors set to the task of examining the treated area with a reading glass after brushing on a 10 per cent solution of sulphuric acid. Only time will tell as to the security of the bond of the sprayed coating or the danger from cracking, crazing or other types of failure that may occur under service conditions. Thus, although the indications are good and there is hope for the best, final judgment is reserved until the sulphur silicate coating shall have been fully tested in service for a period of years.

Some critics are of the opinion that the sulphur will be broken down eventually by sulphur-oxidizing bacteria, and they cite certain failures (described by Beckwith and Bovard, *Chemical & Metallurgical Engineering*, October, 1933) in support of their opinion. However, in spite of this adverse opinion, it is thought worth while to continue with the experiments and, at least to a limited extent, to continue to use this material in the protection of structures against attacks of H_2S gas.

Bitumen, paraffin and tile linings

Protective coatings making use of asphaltic or bituminous bases have been found effective under service conditions for as long as five years. The objection is that when the volatile oils finally escape, the coating shrinks, cracks or crazes to such an extent that its usefulness ends.

Hot paraffin applied under pressure has been used on fairly large areas but only at locations so inaccessible that observation has been difficult. On certain test plaques, where slightly porous concrete has been impregnated with paraffin to a depth of $\frac{1}{8}$ in., signs of disintegration appeared under very severe gas conditions in some of the samples, while others resisted less intensive gas conditions.

In brick sewers the preferred construction calls for an inner ring of hard-burned, low-absorption, segmental-cut brick with poured sulphur-silicate joints. The outer courses in such sewers should be constructed of ordinary brick laid in portland cement mortar.

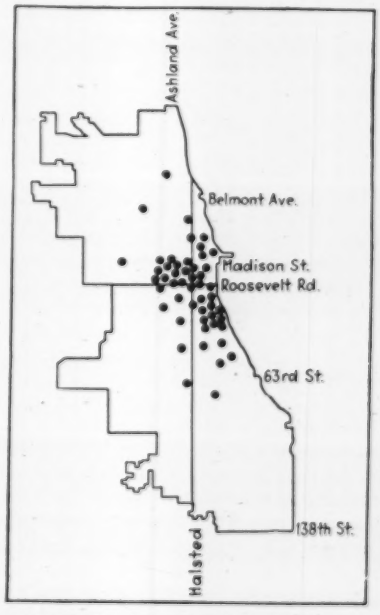
Formerly in precast or monolithic concrete sewers 30 in. or more in diameter subject to intensive gas conditions, it was required that the interior be protected by tile liners. The method of construction was to place on collapsible internal forms a special tile which had lugs on the back to bond with the concrete poured subsequently. Later specifications were changed to provide for grinding the contacting edges of the tile to make a close fit. Still later it become the practice to leave the joints between the tile in their original condition and to fill them with molten sulphur-silicate compound poured prior to the placement of concrete. Still more recently experiments have been made in casting sulphur-silicate liner blocks of the same general size and shape (including lugs for bonding) as the tile liners. Then, after the concrete structure had been poured, all joints between the liners are run over with a hot iron, melting and fusing together the edges of adjoining blocks so that the joint is practically eliminated and a continuous uniform surface of sulphur silicate is presented to all future attacks of gas or acid.

Demolition Progress in Chicago Over Eight-Month Period

FROM MAY through December, 1934, 1,109 buildings unfit for habitation were demolished in Chicago through the official sponsorship of the state housing board, utilizing an average of 450 relief laborers with a maximum of 750 wreckers on the job. Demolition activities were initiated by the Metropolitan Housing Council and has been carried out through cooperation with the Illinois Emergency Relief Commission and the city of Chicago's mayor's committee on sub-standard housing.

All of the buildings have been removed with the owners' consent. So far, technical and legal restrictions have been such that condemnation proceedings have not been necessary. Repairs have been made on 418 buildings. A detailed survey of 6,001 buildings disclosed 3,474 ready for demolition and 2,527 that should be repaired or demolished. On Feb. 1 the state housing board had 70 buildings, and the mayor's committee 81 buildings awaiting demolition.

As the state housing board expects to retire on April 1 from this activity in Chicago, the mayor's committee on sub-standard housing will continue the work. Wreckers have paid $1,527.25 for the salvage, but in only 7 per cent of 200 cases was there enough salvage to pay the expenses of the wrecker's supervision.



PROGRESS of slum demolition in Chicago from June to December, 1934. Each dot represents twenty demolished buildings.

Weighing Bridge Reactions With Proving Rings

Instruments familiar in calibrating work on testing machines adapted to successful use for adjusting truss reactions during construction of continuous bridges

By C. M. Spofford
Hayward Professor of Civil Engineering, Massachusetts Institute of Technology, Boston;
and C. H. Gibbons
Baldwin-Southwark Corp., Philadelphia, Pa.

IT HAS LONG BEEN recognized that a definite knowledge of the actual pier reactions of continuous bridges would be of exceptional value to the bridge designer and constructor, since the assumed reactions are seldom if ever attained because of such things as changes in relative elevation of the piers, variation in modulus of elasticity of built-up steel members and differences in length of the various truss members as they come from the fabricating shop. Hydraulic jacks have been used to weigh reactions, but they have never been very satisfactory. Three years ago a calibrated elastic loop or proving ring was used with great success in determining the reactions of a bascule lift span. Within recent months such proving rings have been used on the new continuous-truss bridges over Little Bay in New Hampshire (*ENR*, Sept. 27, 1934, p. 387) and over the Cape Cod Canal in Massachusetts (*ENR*, Jan. 25, 1934, p. 107), and have proved to be wholly satisfactory and highly accurate. This article describes the elastic loop, whose most familiar field of usefulness heretofore has been in calibrating laboratory testing machines and presents the technique of its application to the problem of the continuous bridge.

Advantages of continuity

Bridges in which the trusses or girders are continuous over two or more spans have not been built extensively in the United States probably because, being statically indeterminate, complicated computations are required to determine the stresses in such structures and also because settlement of the piers or abutments modifies the computed stresses. In recent years, however, a number of important continuous bridges have been constructed in the United States and Canada, among which may be mentioned the Lachine Bridge over the St. Lawrence River; the Sciotoville Bridge over the Ohio River; the Bessemer & Lake Erie Bridge over the Allegheny River; the Hudson Bay Bridge over the Nelson River; the Cincinnati, New Orleans & Texas Railway Bridge over the Ohio River; the Lake Champlain Bridge; the Little Bay Bridge in New Hampshire, and the bridges across the Cape Cod Canal at Sagamore and Bourne, Mass. The Queensboro Bridge in New York City is also a continuous structure, although it is generally spoken of as a cantilever.

As compared with simple span bridges, either the cantilever or the continuous bridge is more economical for spans of considerable length and, moreover, both can be erected without the use of falsework in the main channel span, a condition that often must be met. The continuous bridge has the considerable advantage of fewer expansion joints than either a simple span or a cantilever bridge. Continuous bridges also have greater rigidity than cantilever bridges, since the maximum deflection is in general less in magnitude and occurs less rapidly. The lateral bracing can be made continuous throughout, and hinges with their troublesome details, such as are needed in a cantilever bridge, may be omitted. While the computations required for the continuous bridge are more complicated than for simple span or cantilever bridges, the methods of making them are well understood by recent graduates of our leading technical schools and offer no difficulty except that of additional labor.

With respect to the effect upon the stresses of the settlement of piers and abutments of continuous bridges, little concern need be felt unless the foundations are so bad that it would probably be unwise to construct any type of long-span bridge upon them. Moreover, most of the settlement of the foundations occurs during the construction period, as the weight of the masonry and superstructure is added. Inasmuch as the dead-weight reaction, due to the superstructure, can be established by jacking and weighing (as described in this article) after the trusses are completed, the effect of construction settlement may be accurately evaluated, and the bridge adjusted accordingly. A moderate settlement due to live loads does not greatly affect the total stress in the members of a long-span bridge, particularly a highway bridge with concrete deck.

Weighing reactions specified

In the erection of a continuous bridge, provided falsework is not used under the cantilever arms, the ends of the anchor arms generally must be jacked both longitudinally and vertically, to bring the free ends of the center span together. Since the value of the dead-load reactions is affected by the amount of this jacking, some method of establishing the desired reaction in the field is necessary. In the specifications for the Lake Champlain Bridge (*ENR*, Nov. 21, 1929, p. 796) it was required that the end dead-load reactions be established by weighing with hydraulic jacks and gages, but this method was not found to be satisfactory owing to the difficulty of determining the value of the friction of the hydraulic packing in the jacks and to inability in maintaining the hydraulic gages in accurate calibration when handling them under job conditions. Subsequently, however, proving rings or elastic lops had been used with complete satisfaction in weighing the reactions of a bascule span in New Jersey, and when the specifications for the Little Bay Bridge at Dover Point, N. H., and for the Cape Cod Canal bridges were being written, late in 1933, the engineers (Fay, Spofford & Thorndike) decided to include a paragraph requiring the accurate determination of the reactions on the three-span continuous trusses of the bridges, contemplating that proving rings could be used. This specification paragraph was as follows: "Devices satisfactory to the engineer, and of such degree of precision that the reactions applied to the trusses may be measured with an error not greater than 1 per cent, shall be used in the jacking process." The proving rings used by the contractors for establishing the reactions on all three of these bridges more than met this specification.

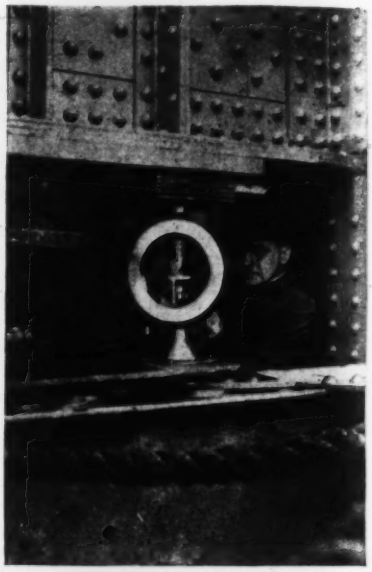


FIG. 1—TAKING DEFLECTION readings on two 200,000-lb. proving rings as they carry one corner of the three-span continuous-truss bridge over the Cape Cod Canal at Bourne, Mass.

The earliest use of elastic properties of materials as load-measuring devices will probably never be known with certainty. One of the early uses doubtless was when Captain Eads, about 1870, devised a calibrated steel rod, to check the accuracy of two testing machines that he had had built. A few years later A. H. Emery built for the National Bureau of Standards a measuring device which more nearly approached the present-day elastic loop. He took two steel plates and joined their ends by flexure plates (these are well-known features of the testing machines and weighing scales built to his designs), to form a rectangular structure., with the flexure plates vertical. This device was placed so as to cause the load to be measured to pass along its vertical axis, and deflections were measured micrometrically. After the relation between load and deflection had been determined by calibration of the device under known loads, it was used to calibrate testing machines and for other similar purposes. Elliptical or oval elastic lops have been used in foreign countries, but it was not until about ten years ago that a circular elastic loop was developed and patented by H. L. Whittemore and the late S. N. Petrenko, of the Bureau of Standards.

A proving ring is essentially a load-weighing device, although it uses neither lever-and-poise nor pendulum —common devices for the measurement of the attraction of the earth for a mass. Essentially, it is a spring, and when loaded axially it assumes a slightly elliptical form, the long axis horizontal. In order, then, to effect accurate measurement of load, it is necessary only to find a means of measurement of this deflection.

This problem has been solved by the use of the vibrating reed—a thin spring-steel strip loaded at the end by a small mass — and a carefully constructed micrometer screw with vernier (Fig. 2). A disk with rounded central projection anvil is mounted on the micrometer screw. The periphery of this disk is divided accurately into 100 (or 200, depending on size) divisions. The index mark is on the vertical standard, which is close by but not touching the disk.

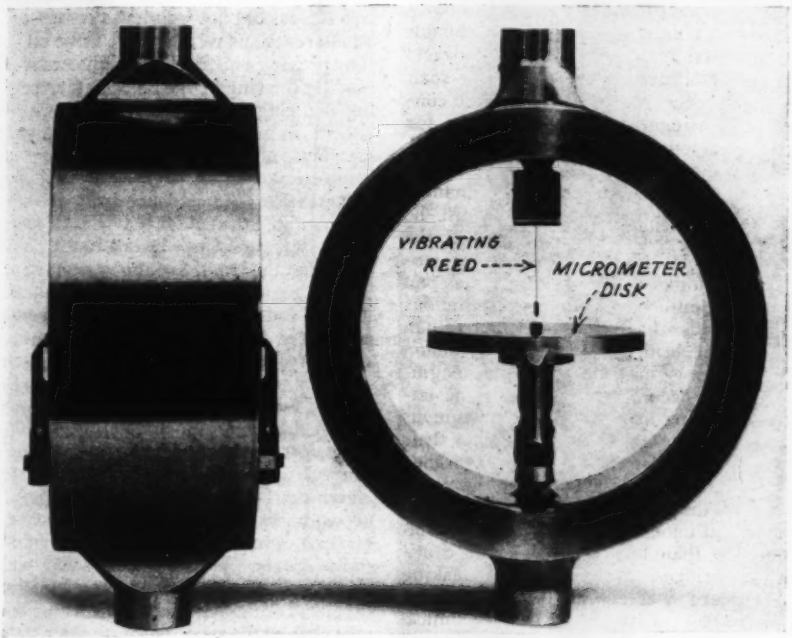


FIG. 2—TYPICAL PROVING RING, showing vibrating reed and micrometer disk. By turning the disk until it makes contact with the end of the vibrating reed, an unusually accurate measure of the diameter of the ring is obtained. The difference in diameter between a no-load reading and a reading under load furnishes a figure directly convertible into pounds by means of a calibration equation.

In operating one of these proving rings the reed is set in vibration by pushing it sidewise and releasing. The disk is turned (the anvil rising) until the anvil just contacts the mass on the end of the vibrating reed. The quality of contact is judged by one (or all) of three criteria: the tone of the vibrating reed, the time of decay of the vibration, and the "feel" of the vibrations in the ring structure.

On good authority it is said that the sensitivity of these indicating devices is such that a change of 1 lb. at a load of 100,000 lb. is detectible. Guaranteed accuracies are 1/10 of 1 per cent and calibration is made at the National Bureau of Standards, Washington, D. C. On the average, a deflection of 0.060 in. is allowed for full load.

Rings up to 300,000-lb. capacity have been built by the Morehouse Machine Co., York, Pa. The Bureau of Standards has three rings of such capacity, while the Baldwin-Southwark Corp. and associated companies have five rings of 200,000-lb. capacity each. A 200,000-lb. ring requires about 22 in. in vertical height and about 13 in. in transverse dimension.

This then is the instrument—a circular ring of high-strength steel, whose change in diameter under load is measured by means of a vibrating-reed indicator and a micrometer disk, this change then being translated into pounds by a calibration equation—which has been adapted to use in weighing the reactions of continuous-truss bridges.

Weighing a bascule

The initial use (so far as is known) of these devices in the determination of bridge reactions was in April, 1933, when the unbalance of a 90-ft. single-leaf bascule bridge was determined by the insertion of two 200,000-lb. rings between the outer end of the leaf and the pier upon which it rested. This determination was made for the American Bridge Co. at the suggestion of David S. Fine, assistant engineer of the erecting department. Readings were taken with the end of the leaf at various heights above the pier and also progressively, as the bridge was lifted and as it was lowered from position to position. Counterweight was added as indicated by the proving-ring determinations, and an excellent balance of the bascule leaf was obtained.

Weighing continuous bridges

The first use of proving rings for weighing continuous-truss reactions was on the Little Bay Bridge in New Hampshire. This structure consists of a channel crossing in a three-span continuous layout (Fig. 3), flanked by

FIG. 3—THREE-SPAN continuous-truss bridge with proving rings located so as to measure the reactions at both ends. Outline of Little Bay Bridge is shown. The Cape Cod bridges are similar except that the main span is a high arch with the roadway suspended beneath.

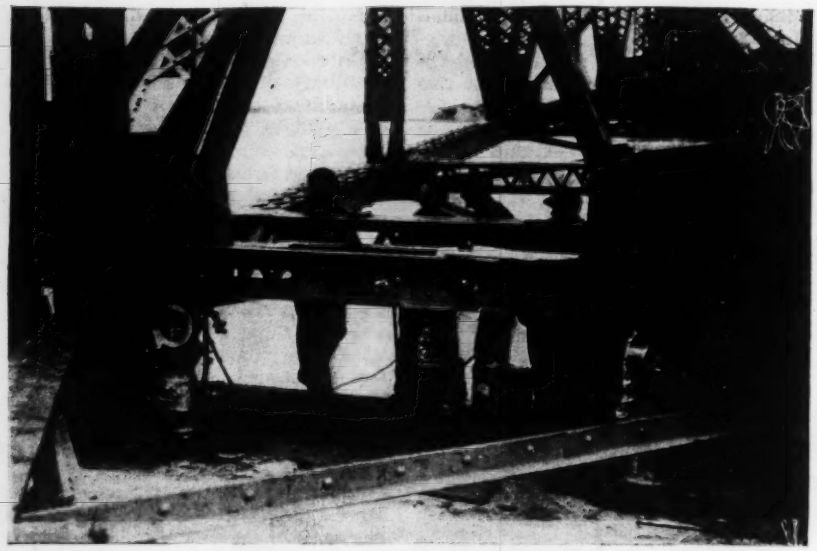


FIG. 4—WEIGHING THE REACTION at one end of a two-span continuous truss on the Little Bay Bridge in New Hampshire. Note that proving rings are set on jacks.

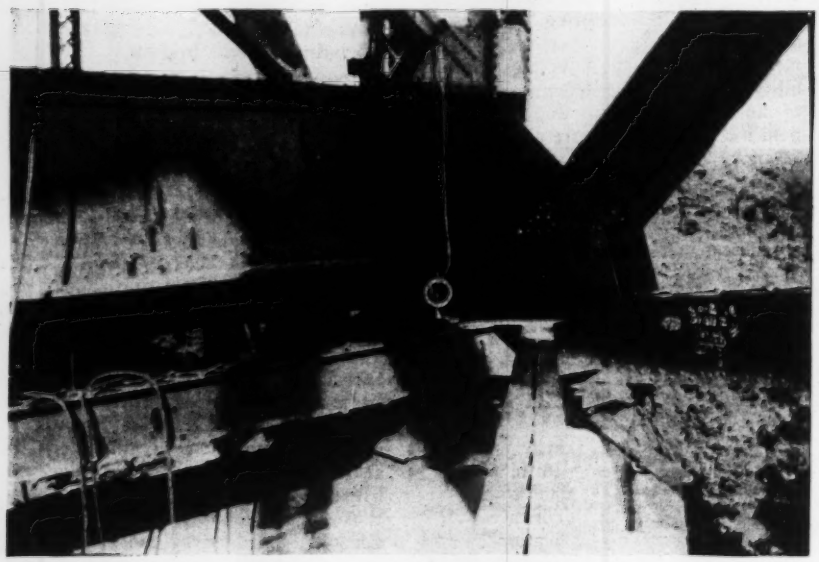


FIG. 5—WEIGHING SET-UP on one of the Cape Cod bridges, showing special reinforced girder installed to provide a jacking reaction and to furnish the means for transferring the bridge load to the proving rings. A rope is attached to the proving ring as a precaution against its falling from the pier.

three deck truss spans on either side; two spans of each of these three span groups of deck trusses are also continuous. The principal use of the proving rings was on the main three-span layout made up of a 275-ft. center span and 200-ft. side spans. However, in June, 1934, while the bridge was being erected, floods took out part of the falsework under one of the continuous-truss side spans, making it advisable to check the reactions. These reaction determinations were made with proving rings mounted on hydraulic jacks. The truss shoes were set at various elevations, readings were taken and a curve of reactions was plotted. Since the desired reactions were known from previous calculations, it was easy to determine the required elevation at each pier, and by the use of packing pieces to bring the trusses to these elevations.

The reaction determinations on the main three-span continuous truss were made a few weeks later. In this case the rings were not placed on the jacks, as they were during the determination of the side-span reactions (Fig. 4), because of inconvenience of manipulation, but instead were set on auxiliary supports resting directly on the piers. The truss ends were first jacked high enough to permit the insertion of the two rings, each mounted on several plates of definite thickness (Fig. 1). The jacks were then exhausted, the truss ends settling on the rings so that the entire reaction passed through them. At that stage the continuous-truss portion of the bridge was supported on proving rings at the outer ends of both anchor spans, on fixed shoes at one main pier and on rollers at the other main pier.

Deflection readings were then taken on the proving ring at each corner. Converting these readings into reactions, the four values were compared, and if not in close agreement among themselves and with the theoretical value, adjustments in the height of the truss shoes were made and the reactions were again determined. Telephone communication was provided between the observers at the opposite ends of the span, to assist in this work.

On this bridge it was found that the two trusses did not weigh the same—that is, the reactions were not the same on the four proving rings. Two engineers were reading the rings (one on each pier reading two rings), and the results were not known in pounds of load but only in divisions of deflection, until after the completion of the series of readings. Nevertheless, the evidence from one pier corroborated the evidence from the other. This discrepancy may be due to the possibility that the lengths of the various members in the trusses are not identical, and that the ends of one truss, in consequence, may have been at different elevations (with respect to the elevations of the supports at the two middle piers) than the ends of the other truss.

In using proving rings for weighing operations, certain preparations and precautions are required. Not only for weighing but also for possible future adjustments of the span ends, jacking girders should be provided between the end verticals. At the span ends where the reactions are to be weighed, these girders should be designed of sufficient strength to take care of the reactions with the trusses supported either on the hydraulic jacks or on the proving rings. With through trusses, end floor beams may be used in place of the jacking girders.

Inasmuch as the final elevation of the ends of the trusses will probably vary somewhat from the designed elevations, provisions have to be made in the design and specifications to permit the adjustment of the floor construction after the continuous truss ends are set at the heights determined upon to give proper reactions. Finally, if the ends to be jacked rest upon abutments, the floors, fence and curbs of the latter should not be completed until the jacking has been done; if other spans adjoin the continuous spans, jacking girders or other devices should be provided to permit the adjustment of the heights of these spans.

Cape Cod Canal bridges

The next use of the proving rings was on the Cape Cod Canal bridges. These two structures, located at Bourne and Sagamore, Mass., are identical so far as their continuous portions are concerned. Similar to Fig. 3, except that the center

span has a much more pronounced arch, these bridges have a center-span length of 616 ft. and flanking spans of 396 ft.

The reactions on the Bourne bridge were determined in October, 1934, and on the Sagamore bridge in February, 1935. Due to the magnitude of the pier reactions on these structures (on the order of 500,000 lb. at each end), it was necessary to weigh one end of the bridge at a time, since there were only four 200,000-lb. proving rings available. Thus the operation was somewhat different than on the Little Bay bridge, where the reactions at both ends were determined simultaneously.

At Cape Cod the rings were set on a pier in pairs just inside the trusses. Then, as the truss ends were jacked to a designated height, the truss ends on the pier at the other end of the bridge were elevated correspondingly, although there was no weighing apparatus at that end. After a complete determination on one pier, the four rings were moved to the other pier, at the opposite end of the bridge, and the process was repeated, the levels on the pier where determination had been made being varied to correspond to those previously attained when the weighing was being done.

Altogether, this method provides the bridge engineer for the first time with a method of real accuracy for the determination (and variation as desired) of pier reactions on continuous-truss spans. While there is no thought that this method shall lead to any marked increase in the adoption of continuous-truss bridges over other types, it does provide means of the elimination of several of the uncertain variables in the construction of this type of bridge.

Current Research Activities of the A.S.T.M.

COMMITTEES of the American Society for Testing Materials are continually carrying on research programs, to provide the new information upon which future standardization may be based. This research work is reviewed annually by the committee on research, and last year's summary included 114 research projects of which the following are particularly interesting to the civil engineering and construction field. Progress reports on many of them will be presented at the annual meeting of the society in Detroit, June 24-28.

Committee A-1 is beginning work on the development of inspection methods and recommended practices for surface imperfections in structural steel. It is also assisting in an investigation of the effect of phosphorus and sulphur in steel and in a study of the yield point of structural steel.

Committee A-2 is studying the quality of wrought iron, with particular emphasis on the influence of raw material and processes of manufacture. The optimum amount of manganese is being given special study.

Committee A-3 is studying the correlation of properties of iron castings and test bars and is also investigating various methods of impact testing of cast iron.

Research projects under Committee A-5 include atmospheric corrosion tests of uncoated steel and iron sheets, of galvanized sheets, and of metallic-coated hardware, structural shapes, tubular goods, wire and wire products; total-immersion tests on uncoated sheets; accelerated corrosion tests on metallic-coated products; and embrittlement studies of hot-dipped galvanized structural steel.

Committee C-1 has the following research projects under way: compressive-strength test of cement mortars; particle size and specific surface of cement; and volume change and soundness of portland cement.

Committee C-9 has the following projects under way: studies of designing and proportioning of concrete, of concrete aggregates, of deleterious substances in concrete, curing, workability, admixtures, elastic properties, and permeability. Conditions affecting the durability of concrete in structures, methods of analyzing concrete and of making field tests for concrete are also being investigated.

The committee on paint and paint materials (D-1) is making accelerated tests for protective coatings, studying anti-corrosive and anti-fouling paints, and investigating the physical properties of paint materials.

New methods of testing the soundness of lime and the plasticity of hydrated lime are being studied by Committee C-7.

In the field of bituminous materials, Committee D-4 is investigating methods of separating cutback asphalts and of testing bituminous emulsions. Committee D-8 is investigating accelerated weathering tests of bituminous roofing materials and studying tests of bituminous joint compounds for sewer pipe.

In the field of timber, Committee D-7 is giving consideration to methods for making two types of moisture determinations, the first an accurate method for laboratory use and the second a method sufficiently accurate and practical for field use.

Leakage in Long Pipe Line Found Small After Two Years' Service

AFTER being in service for two years the 25-mile 36-in. cast-iron pipe line from Ashland to Lincoln, Neb., was tested last fall in accordance with the contract specifications. The original test made directly after completion indicated a remarkably tight job, and the recent test shows that the leakage is still far below that specified as allowable. The original test made by the contractor (*ENR*, April 20, 1933, p. 487) gave an average leakage of 11.18 gal. per day per mile per inch diameter of pipe. The final test, made in October, 1934, by the city averaged 25.2 in.-gal.

The second test was conducted in the same general manner and with the same equipment as used by the contractor in the first test. As the line was purely a supply main, there are no cross-connections and no water leaving the line between Lincoln and Ashland. The main was tested in four sections between valves. The leakage was determined by measuring the drawdown in the water level in a large tank from which the test water was taken. The figures in the accompanying table in both cases represent the total leakage for the section tested, including any leakage from blowoff valves, air-relief valves and large valves at each end of the section.

ASHLAND-LINCOLN
LEAKAGE TESTS ON PIPE LINE
(25 miles long, 36-in. diameter)

Sect.	Length, Ft.	Leakage in Gal. per 24 Hr. per Mile per Inch Diameter	
		1932	1934
A	51,200	10.16	17.8
B	29,700	15.95	52.2
C	31,600	6.02	11.1
D	20,100	14.83	26.4
Average		11.18	25.2

The specifications provided that the leakage should not exceed 100 in.-gal. during both tests. "Water Works Practice," the manual of the American Water Works Association, sets up a standard figure of 200 in.-gal.

In section B of the line (see table) there were valves which it is believed were not closed absolutely tight, inasmuch as manipulation of them closed off part of a larger leakage showing during the preliminary tests.

The original pipe was laid and tests carried out under the direction of D. L. Erickson, city engineer. Abel and Dobson were the contractors.

AN ENGINEER'S RECOLLECTIONS

By JOHN F. STEVENS

Consulting Engineer, Baltimore, Md.

·II·

C.P.R. Location in the Rocky Mountains

Snow makes trouble in the mountain passes in the early season and threatens to cut off sources of food supply as winter comes down—Bacon and beans as the pièce de résistance three times a day

THE FOLLOWING ARTICLE is the second of a series of recollections of engineering experiences by John F. Stevens. The first article, together with a brief outline of Mr. Stevens' career, was published in our issue of March 21, p. 412. —EDITOR.

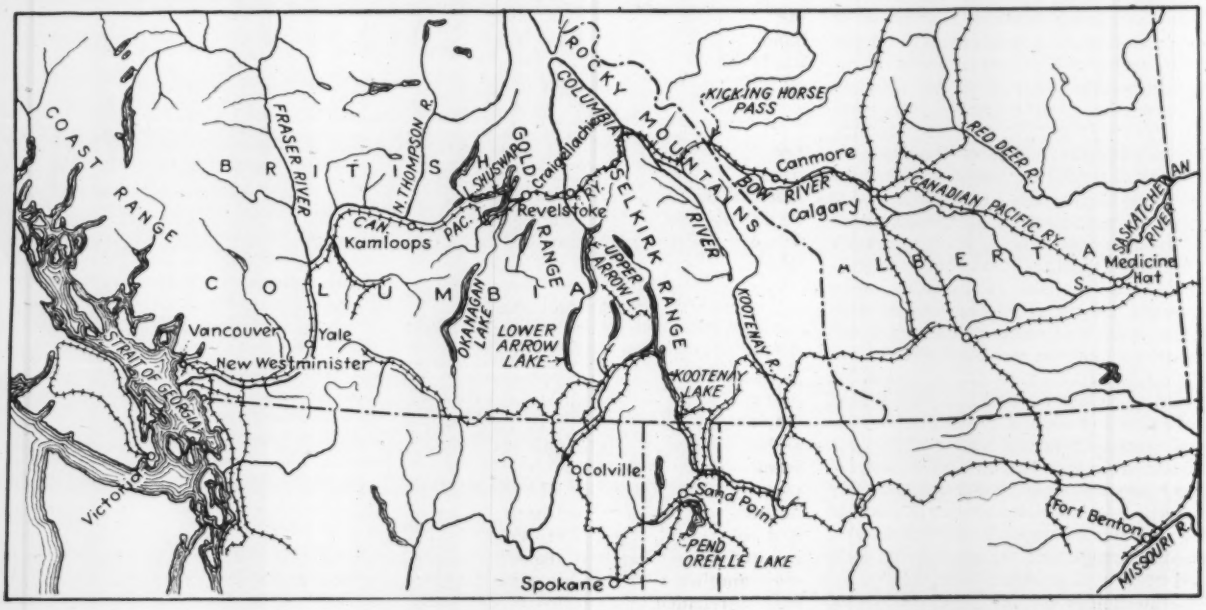
IN MARCH, 1883, I accepted an offer to enter the service of the Canadian Pacific as assistant engineer of location in the mountains, under Major A. B. Rogers, who the previous year had been employed on reconnaissance for the railway company in the Rocky and Selkirk ranges. Leaving Minneapolis as soon as the weather conditions in the mountains gave promise of allowing the work of surveying to be started, I went to Winnipeg and over the new road to the end of the track, some 40 miles east of the South Saskatchewan River. Here the company had collected about 30 Red River carts to transport our supplies and camping outfit to the mountains. In company with the other engineers and men enough to make up three full locating parties, I went with the carts as far as they could be taken, which was what was then called the "Gap," the entrance to the mountains, about 25 miles west of what is now the fine large city of Calgary.

Calgary at that time consisted of possibly a dozen log houses, the principal one being a trading post which supplied the trappers and the few wandering nomads and stock raisers of that vast land. The only connection that it had with the outside world was by means of "bull teams," which hauled its supplies from Fort Benton, the head of navigation on the Missouri River in Montana. I remember that the evening of our arrival at Calgary some teams came in from Fort Benton, and among other supplies they brought half a dozen boxes of apples, the first ones that ever were seen in that part of the Northwest. It marked an epoch, and as a token of extreme hospitality I was presented with two of them, which I appreciated, as they were being quickly disposed of at fifty cents each, only about twice as much as is charged in New York in these latter days.

THE CANADIAN PACIFIC RAILWAY in the spring of 1883 ended about 40 miles east of the South Saskatchewan River. Transportation west of there was by Red River carts as far as the entrance to the mountains, about 25 miles west of Calgary, and by pack animals through the mountains.

Into the mountains

As we had taken the carts with our outfits and supplies as far as practicable, we were halted for several days while we were collecting pack ponies and packers for the remainder of our journey. To supplement what few ponies we had that could be packed, we got 30 more from the Stony Indians, a tribe that lived in that region. As the only way we could get them was to take along an Indian with each pony, we certainly were a motley gang as we left the Gap (Padmore was its uncivil-



ized name, Canmore I believe now) and pulled out for the tedious and extremely hard trip across the Rockies and down west across the Columbia River to the Selkirk Range.

We followed the beautiful valley of the Bow River to the summit of the Rocky Mountains, crossing it at Kicking Horse Pass, through which we shoveled our way in 7 ft. of snow. With the miserable means of transportation with which we were provided, the journey was much harder than it should have been. Still we had our diversions. I found some excellent trout fishing in the Bow River, although the season was too early to use a fly.

It was a curious thing, but at some previous time Methodist missionaries had gotten into that country and converted (?) the Stony Indians to Christianity. At night in camp after the Indians had been fed up (a long job, for they were apparently hollow from head to foot) they would sit around their camp fire and sing the old Methodist campmeeting songs in English, not a word of which they understood as far as I could ascertain. It was a weird entertainment, but as they were inveterate thieves and had other failings, I felt, as I have since in some other lands, that practical Christian religion does not strike very deeply into the native consciousness.

KICKING HORSE CANYON up which the party attempted to work its way eastward through the pass in the late fall of 1883, only to find that deepening snow had made that route through the mountains impracticable.

Location work begun

We finally reached the Columbia River, and, gladly sending our Indian contingent back, we started our engineering work. My especial territory began some 30 miles up east on the Kicking Horse River toward the pass of that name, and extended west down to and across the Columbia River and up to the summit of the Selkirk Range. We were favored with fine weather and made rapid progress with our survey, although much of it was through a very rugged country where at times progress was necessarily slow.

Major Rogers, my chief, came over twice during the summer to see us, but never remained more than a couple of days. He was an energetic man, but his previous engineering experience had been mostly in a prairie country, and I was left quite to my own judgment in the laying of the line. He was a monomaniac on the subject of food, and had a strong liking for that which cheers and also inebriates. We usually had plenty of bacon and beans, and they were our pièce de résistance three times a day, as he believed that a variety of food, and much of it, did not conduce to physical or brain acitvity. Our line of supplies began at Spokane, Wash., thence by rail to Sand Point, a station on the Northern Pacific Railway at Pend' Oreille Lake, thence by pack ponies through the wilderness to the head of the Columbia River, and from there by canoes to our camp. As there never were any reserves of food in stock, sometimes when a canoe was overturned or a packer got drunker than usual, we were left to guess how long we could continue to eat.

Much of what might properly be called our local transportation was done on the Columbia River, and the moving of camp, of supplies, etc., was handled by means of an old leaky small flat boat that had somehow drifted down the river, probably brought by prospectors and abandoned. As we had a few tools, we made a couple of dugouts (*cayugas*, in the tropics) out of big trees and managed as best we could. Our chief's ideas of economy were very, very fantastical. An engineer had a fine opportunity to display his versatile talents.

Another route to be surveyed

We got through our season's work in good shape, and when the snow began to fall we thought it time to move out, as we had no store of provisions and very few clothes, and our supply from Spokane was cut off by approaching winter. But while the other two locating parties who had been working east of mine were taken out, I was ordered to remain and make a survey over another route which some trapper had persuaded the railroad company was better than the one we had been at work upon all summer. The alleged route proved to be of no value.

I cheerfully accepted the situation, although most of my men did not like it, but I insisted that a sufficient supply of food should be brought in from the east to last us all winter in case we got snowed in, which the company agreed to do, and we went on with our survey, completing it in about a month. Meanwhile the snow got deeper and deeper, and no supplies were in evidence, and as I had received no communications whatever during that time from anywhere the situation began to look rather dubious.

Trouble in Kicking Horse Canyon

I had about fifteen pack ponies, and so, packing a part of our stuff on a few of them, I started with them and half a dozen men on the back trail up Kicking Horse River east toward the pass, more as a matter of experiment than anything else, and I soon discovered why no supplies or word had reached me. The trail was impassable, and in an hour I lost all of these animals by their slipping off the icy trail into the canyon some hundreds of feet below. Thus no further retreat could be made in that direction. We crawled up into the canyon the best way we could from

camp, salvaged the most of the outfit that had been lost, although in rather a deplorable condition, and went back to the old camp on the Columbia River.

I knew that there was a pass through the mountains at the head of the creek that I had last been surveying, and that the previous fall there had been a party of the company's engineers somewhere up there. So I advised my men that I was going to try to get out that way and get some relief to our camp, and that I would take a few men with me, if they chose to go; but only one man decided to take the chance. Taking a little food, our blankets and the notes of my summer's work, I started with one man going eastward up an unknown creek, which I had been told led by way of a pass to a tributary of the Saskatchewan River, far east of the mountains.

We made our way with much difficulty, crossing the pass and finally overtaking the party of engineers, who had been ordered out and already were on their way. We traveled with its members several days, but the progress they were making was too slow for us, and so we struck out ahead, taking a route of our own. We got through all right but were two days with only one slight meal, snowshoeing amid weather certainly away below zero. I had taken very little food, and we were three days in making a trip which I expected to make in a day and a half, due to misleading information picked up at the engineers' camp. By a stroke of benign Providence we met in that unknown wilderness a party of men well equipped, with large supplies of food, which the railway company was sending to our relief, taking that route after failing, as we had done, to negotiate a passage by way of the Kicking Horse River.

Our meeting with this relief party was in a small way dramatic. The man whom I had with me was a powerful chap, but for the last day, owing perhaps to fear as well as to hunger, he had begun a line of talk to himself which did not sound good to me. He muttered something about cannibalism several times. As he carried the axe, I thought it prudent to keep him ahead of me, which made it necessary for him to break trail, which I had been doing most of the time. Suddenly I stopped, listened a few seconds and then said, "I hear a dog." "No," said he, "'tis a tree squeaking in the frost you are hearing, there ain't a dog within a million miles." But I pushed on as fast as I could and met a big dog bounding through the snow and barking to greet me. Never was the sight of a dog more welcome, and I love them all. In another moment the party came in sight, and we got a real meal, the first for two days.

The relief party went on over the route to my camp on the Columbia River that I had followed in coming out, and brought all of my men to the east of the mountains in good shape. On reaching the end of the track, which was then on the Bow River a few miles east of the summit, I rested up a couple of days and then went by rail to Winnipeg and so on home to Minneapolis, where I found that my wife and friends had about given me up, as the newspapers had reported us hopelessly lost, until the news had come of my return across the mountains. As usual I remained at home in enforced idleness for some months waiting for spring to come again.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, it is planned to publish monthly a small group of short abstracts of articles and papers published in other languages than English. In these abstracts no attempt will be made at a compendium of foreign-language articles; selection will be made only of articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness.

Previous groups of these abstracts from foreign periodicals have been published in *Engineering News-Record* of Jan. 31 and Feb. 21, 1935.

Trailer for railway cars

An innovation which may revolutionize German railroad operation is described by W. Bode in *Organ fuer die Fortschritte des Eisenbahnwesens* of May 1, 1934. To facilitate freight delivery, the Machine Construction Bureau of the Railroad Administration of Germany has developed a rubber-tired trailer which will carry a fully loaded freight car and will be hauled over average streets and highways by a 100-hp. six-wheel motor truck at a speed of 11 miles per hour. The weight of this trailer is about 10 tons, the weight of a German freight car is 12 tons, and the average weight of its load is 22 tons; thus the total weight of trailer, car and freight is about 44 tons.

The trailer consists of two underframes rigidly coupled together. Each underframe rests on four jointed cross-shaft axles, two in a row, which are supported on four pairs of wheels, provided with solid extra-elastic tires nearly 10 in. wide. The entire trailer is supported on sixteen wheels, and the load on each wheel amounts to 2.75 tons. Each underframe carries a 3-meter (9.84-ft.) length of standard-gage (4-ft. 8½-in.) railroad track, which receives the freight car as it leaves the track of the loading ramp. As the freight car is loaded on the trailer the two underframes are first drawn together, to form a continuous track length of 6 m. (19.7 ft.) and are subsequently pulled about 5 ft. apart, to accommodate the full length of the car, which is about 27 ft.

In preparation for the trip, the hinged rail portions, directly under the car wheels, are lowered about 8¼ in. by means of hydraulic controls, which takes

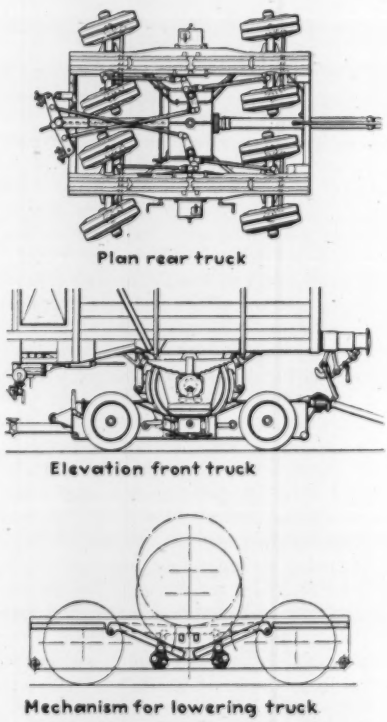


FIG. 1—TRAILER for hauling freight cars over city streets—a new feature of German railway practice.

about 20 sec. It takes 2¼ min. to raise the car to its original position. About 8 min. are required to load a car on the trailer, and 11 to 12 min. to take it off and back to the ramp.

Frost rupture of pipes

The results of a study of bursting of water-service pipes in cold weather, made on behalf of the Domestic Engineering Division of the Union of German Engineers (Verein Deutscher Ingenieure), are reported by M. Mengeringhausen and G. Ehlers in *Gesundheits-Ingenieur* of Nov. 17, 1934. Tests were made both under natural conditions, at temperatures of 32 to 5 deg. F., and in the laboratory where the pipes tested were packed in solid carbon dioxide. The pipe specimens, which

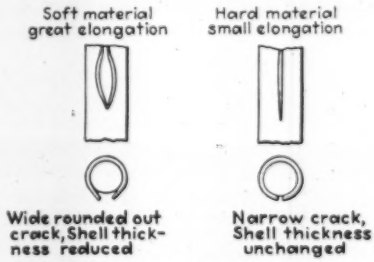

Soft material great elongation
Hard material small elongation
Wide rounded out crack, Shell thickness reduced
Narrow crack, Shell thickness unchanged

FIG. 2—TYPES OF RUPTURE of service pipes due to freezing.

measured ½ in. in diameter and 3.28 ft. in length, were made of the following materials: lead, mild copper, mild aluminum alloy, hard aluminum alloy, welded steel and seamless steel. This study led to the following conclusions: (1) No pipe material will resist the pressure of super-cooled water, unless prohibitive designs are adopted. Thus, a steel pipe about ¾ in. in diameter would have to have a shell thickness of nearly ⅝ in. to stand a frost of only 14 deg. F. (2) Seamless steel pipe resists freezing stresses best, on account of high strength combined with a great percentage of elongation. This is confirmed by the experience of the Berlin waterworks. (3) A great elongation coefficient is also desirable in weaker pipe materials, such as copper. For this reason a mild copper alloy is preferable to a hard copper alloy. (4) It is hopeless to try to combat bursting of pipe in cold weather by specifying uncommon pipe materials. Better results will be achieved by thermal insulation and by installing draining devices for service piping which is not in constant use. Such devices should be automatic, for experience has shown that water-users fail to tend to them.

Distorted models

A significant note of caution is sounded by C. Camichel and his associates E. Fisher and L. Escande reporting, in *La Houille Blanche*, July-August, 1934, the results of the first of their experimental studies of the performance of distorted hydraulic models, i.e., models whose vertical and horizontal scales are not identical. Such models, it is argued, are not geometrically similar to their prototypes, and there is no theoretical reason for assuming that the laws of hydraulic similitude apply to conventional representations of this kind.

Three suppressed weirs, *A*, *B*, and *C*, of triangular cross-section and of the dimensions shown in Fig. 3, were tested in a flume 0.66 ft. wide, at three regimens of flow, all of which were characterized by a head of 0.39 ft. over model *B*. Note that any of the three models may be considered a distorted model of any of the other two.

The distortion of the models did not seem to affect the discharge quantities, which should be in the relationship:

$$3\sqrt{3}\,Q_A = Q_B = Q_C$$

where the subscripts *A*, *B* and *C* designate the respective models. The maximum deviation from the average of three determinations by three weirs amounted to 3.4 per cent of the average.

But when we look at the shape of the nappe and its trajectory, we find that the three models are in utter disagreement, as shown in Fig. 4. In two cases the nappe is of the adhering type. In other words, distorted models, so commonly used nowadays, may not give a qualitative idea of the hydraulics of the prototype.

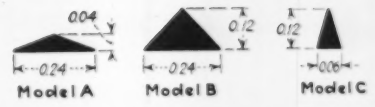


FIG. 3—SECTIONS OF WEIRS employed in tests of the effect of distortion.

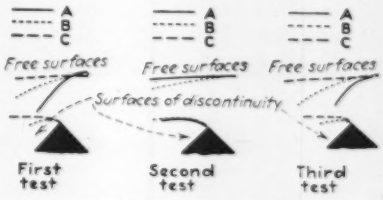


FIG. 4—SHAPE OF NAPPE and its trajectory as affected by distortion of weir.

A similar study of channel erosion models will soon be reported by the same authors.

Recent Spanish dams

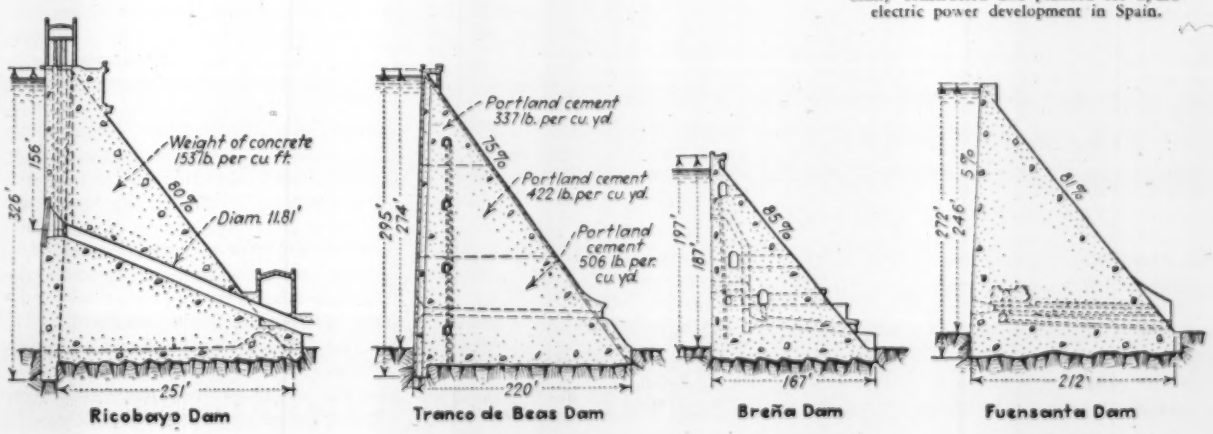
The well-known Swiss engineer, Dr. N. Kelen, who visited Spain in the summer of 1933, reports in the *Schweizerische Bauzeitung* of Oct. 20, 1934, extensive dam construction for hydro-electric power and irrigation, under a twenty-years' public-works program adopted by the Spanish government. Fifteen straight and curved concrete gravity dams, ranging in height from 100 to more than 300 ft., now in process of construction, are listed on p. 454.

The maximum dimensions and the structural features of four of the largest of these dams are shown on Fig. 5.

To save in transportation and storage costs, cement is generally delivered in bulk, in form of unground clinker, which is less susceptible to disintegration by moisture, and its grinding into cement takes place at the dam site, as required.

Concrete mixes for these dams generally vary in richness from 295 to 550 lb. per cu.yd. at the upstream face. Plums constitute 5 to 7 per cent of the concrete yardage, though 15 per cent has been permitted by the designers. In

FIG. 5—SECTIONS of typical dams recently constructed and planned for hydro-electric power development in Spain.



FIFTEEN SPANISH DAMS NOW UNDER CONSTRUCTION

Name of Dam	Watershed	Max. Hgt., Ft.	Reservoir Capacity, Acre-Ft.
Brena	Guadalquivir	197	104,000
Camarillas	Segura	118	32,500
Guerda del Pozo	Duero	108	130,000
Doiras	Navia	290	
Fuensanta	Segura	272	192,000
Jandula	Guadalquivir	280	69,500
Mediano	Ebro	180	94,000
Ordunte	Ordunte	161	18,000
Requejada	Duero	171	53,000
Ricobaya	Duero	326	960,000
Rumblar	Guadalquivir	213	102,000
Toba	Jucar	118	32,000
Tranco de Beas	Guadalquivir	295	406,000
Vado	Tajo	180	31,000
Yesa	Ebro	205	381,000

this country, where lumber is unavailable at low cost, concrete formwork has been usually dispensed with by confining the poured concrete between walls built of precast T-shaped blocks, which ultimately serve as extra facing to both the upstream and the downstream surfaces of the dam. After placing a layer 6.5 ft. thick, 72 hours must elapse before pouring of concrete is resumed. In building the Ricobayo Dam (326 ft. high), which contains 500,000 cu.yd. of concrete, maximum progress was 1,300 cu.yd. per eight-hour shift and 41,600 cu.yd. per month.

Lead-sheet expansion joints are generally spaced 50 to 105 ft. apart. The upper half of the Ricobayo Dam has an extra set of expansion joints extending only about 130 ft. from the crest downward.

Acoustic apparatus for measurement of stresses, also temperature recorders and uplift pressure gages are generally incorporated within the dams.

Designing a cliff

The most interesting feature of the new 35-acre zoological park at Vincennes, near Paris, is an artificial cliff of reinforced concrete rising to a height of 220 ft. and occupying nearly one acre of ground. This "Great Cliff," described by L. Faucheur and H. Durnerin in *Travaux* of June, 1934, shelters the lions and the tigers as well as the birds of prey and offers the mountain goats and the wild sheep a fair imitation of their natural habitats. Furthermore, it serves as an observation tower, made accessible to the public by a centrally located elevator and winding staircase leading to a platform 213 ft. above the ground, and it also houses the standby waterworks of the zoo, comprising two reservoirs: a rectangular one, near ground level, having a capacity of 343,000 gal.; and a round one, 82 ft. above ground surface, holding 211,000 gal.

In designing this unusual structure, wind pressure was neglected up to about the 50-ft. height; above this elevation it was computed by the formula:

$$p = \text{wind pressure in kg. per sq. meter} = \frac{250\ H - 3{,}750}{H + 8.33}$$

where H is height in meters.

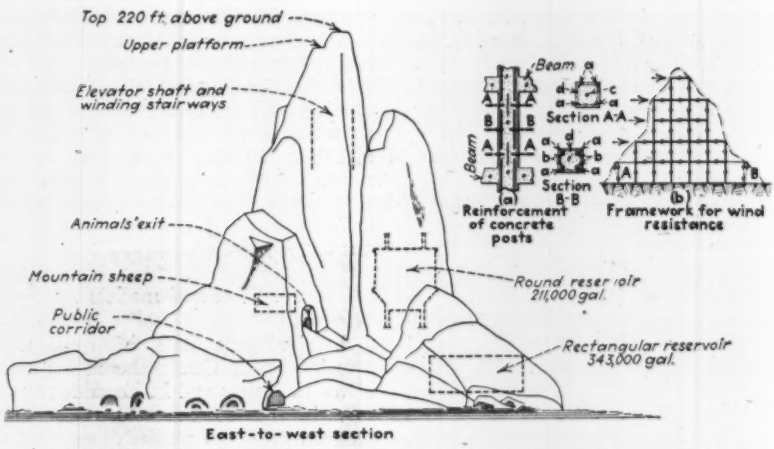


FIG. 6—ARTIFICIAL CLIFF of reinforced concrete for the zoological park at Vincennes, Paris, France.

For an elevation of 164 ft. above ground surface this formula indicates a wind pressure of 30.7 lb. per sq.ft. The values of p as given by the formula were reduced by a coefficient of 0.60 to account for the obliquity of the cliff surface.

The interior framing was designed as a simple rectangular system of reinforced-concrete posts and beams, without any encumbering diagonal bracing, divided into twelve stories, 16 to 20 ft. high. To give this system added flexibility for resisting thermal expansion and wind pressure, the steel reinforcement was placed as shown in Fig. 6a, and each of the post and beam elements was considered hinged at mid-span, as shown by Fig. 6b, in which, for simplicity, only five stories are shown instead of the actual twelve.

The exterior shell was molded by successive depositions of cement mortar coatings on a fine mesh netting of thick wire stretched on the concrete framework of the cliff in accordance with a 1:50 architectural model, indicating precisely all the irregularities, clefts and crevices.

An open-air ramp leads to an observation platform 33 ft. above the ground; and another ramp, partly in open air and partly in tunnel, leads to the staircase at a height of 82 ft. The construction of the cliff took about eighteen months in all.

Columbia River Planning to Continue Without Establishment of Authority

PRESIDENT ROOSEVELT does not favor the creation of a Columbia River Authority at the present time, according to Marshall N. Dana, chairman, Pacific Northwest Regional Planning Commission, and district chairman of the National Resources Board. The President prefers the continuance of the fact-finding and plan-making such as that now in progress by the regional planning commission.

This commission has already undertaken the preparation of a ten-year plan for general development in the Northwest states keyed to the federal power projects at Bonneville and Grand Coulee. Mr. Dana stated that the President was fully informed and interested in the further development of the Columbia Basin. Because of this, it is not likely, according to Mr. Dana, that Senator Pope of Idaho will press his C.V.A. bill at this session of Congress, or that Representative Knute Hill of Washington will urge his bill designating the Federal Reclamation Bureau as the Columbia River Valley Authority.

A system of trunk inland waterways for Washington, Oregon and Idaho is assuming prominence in the plan of Pacific Northwest development, according to Mr. Dana. He said this system involves the use of the Columbia River for an east-west artery from the Pacific Ocean to Lewiston, Idaho, and the joining of Puget Sound, Grays Harbor, Willapa Harbor and the Columbia River in a north and south artery through western Washington. The Willamette River from its mouth to Eugene, Oregon, would also be a part of the system. Development on the Willamette would, if undertaken, be in harmony with other plans for river systems to include flood control, drainage and supplemental irrigation, but probably without power development until the full effect of Bonneville and Grand Coulee is known.

The Army engineers of the Northwest Division have given tentative approval to the canal project extending from Puget Sound to the Columbia River.

Research Notes

—Current Work at the University of Wisconsin

TWO ARTICLES published last year in this series were devoted to current research at the Fritz Engineering Laboratory, Lehigh University (*ENR*, Feb. 15, 1934, p. 225) and the Engineering Experiment Station of Ohio State University (*ENR*, May 24, 1934, p. 666). The accompanying article, carrying on the series, will be followed by others devoted to work at other colleges. Such articles have been planned with two objectives in mind: (1) to give the general reader brief digestible doses of new information which he seldom has the time, inclination or opportunity to dig out of the complete reports when they become available; and (2) to help research men keep in touch with activities in other laboratories than their own. In order to achieve these objectives best, reports on research work at other colleges will, therefore, be gratefully received. —EDITOR.

CURRENT RESEARCH at the University of Wisconsin at Madison is carried on by the various departments of the College of Mechanics and Engineering and touches numerous subjects in which the civil engineer is interested. The following notes cover broadly the fields of highways, strength of materials and hydraulics.

Highways

Three projects are under way in the department of highway engineering and city planning under Prof. H. F. Janda.

Warning Signals—Does the average motorist know the meaning of the shapes, colors and symbols of the highway signs? A recent study of driver reaction indicates that symbols are most effective in warning a driver of approaching danger, but that the standard shapes should be retained in the hope that motor-vehicle operators will learn their significance and thus be forewarned long before the symbol on the sign is visible. (Reported, Highway Research Board, 1934.)

Reflecting Signs—Another study is now under way, to determine the effectiveness of the so-called "night signs." Combinations of reflector symbols and outlines of the various warning signs will be used to determine the most effective method of giving a warning to the motor-vehicle operator. Data on the relation of time of driver reaction and distance from the sign will be obtained.

Designing Bituminous Mixes—In cooperation with the Wisconsin highway commission, a study is under way on the fundamentals of the design of coarse-graded bituminous mixes. A formula for the percentage of bitumen to be used has been evolved by the highway commission laboratory, and this has been used in the field for mixes containing various Wisconsin aggregates and cutback asphalts and tars.

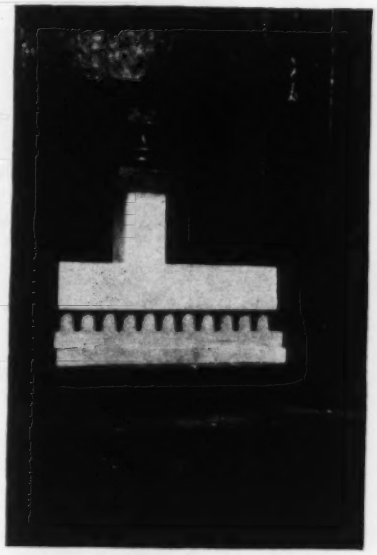


FIG. 1—PLASTER MODEL of a reinforced-concrete column footing under test. Footings rest on rubber blocks, to insure a uniform distribution of bearing pressure.

(Reported, Wisconsin Road School, January, 1935.)

In the department of mechanics there are six research projects of note:

Strength of materials

Concrete Durability — Information leading to the establishment of satisfactory durability tests for concrete and mortar is being sought in an investigation begun in 1930. L. O. Hanson, instructor, has done much of the work in cooperation with the Wisconsin highway department. More than 40 local coarse aggregates have been subjected to artificial freezing and thawing and to sulphate solutions. The freezing test has been employed on concrete with water-cement ratio, consistency, proportioning and type of coarse aggregate as the variables and with both loss of strength and of weight as measures of the effect of the test. Some study has been made of sands, and 24 cements of different chemical composition have been or are being tested in mortars subjected to freezing and thawing. This is part of a Highway Research Board project.

Larger proportions of cement or lower water-cement ratios increased the durability to freezing and thawing of concrete of ordinary proportions. Other conditions being equal, however, the presence of poor coarse aggregate has been reflected in the behavior of the concrete. The loss of strength is considered superior to the loss of weight as a measure of durability. Reported, *Proceedings* A.S.T.M., 1931, and *Proceedings*, Highway Research Board, 1933.)

Vibration of Concrete—A series of tests has recently been completed by Prof. M. O. Withey, to ascertain the effects of vibration in placement on the absorption, density, permeability, strength and resistance to freezing and thawing of concrete mixes of low cement content and dry consistency. An external electric vibrator was used, for the most part. Further tests are now under way.

From the tests thus far made it appears that concrete containing 7 to 9 per cent of cement and a low water content can be made more dense, more watertight and more resistant to freezing and thawing, and of much higher strength when placed by vibration than if poured into the forms. Vibration permits the elimination of excess water. It also appears that reductions in cement content can be made without sacrificing either the strength or durability. (Reported, American Concrete Institute, 1935.)

Plaster Models—An extensive investigation has been made by Prof. R. J. Roark and instructor R. S. Hartenberg, to determine the feasibility of predicting the ultimate static strength of concrete structures and metal castings by tests made upon full-size and small-scale plaster models. In principle, the method comprises the following steps: (1) determination by test of the load P_m carried by scale model $1/n$ times as large as the structure; (2) determination, by tests on suitable coupons, of R, the ratio of the ultimate strength of the structural material to the ultimate strength of the model material; and (3) calculation of the predicted load P that the structure should carry by the relation $P = P_m \times n^2 \times R$, adjusted by suitable coefficients and taking into account differences in the properties of the materials of model and prototype. The procedure involved requires relatively little laboratory equipment and can be carried through quickly and at small cost.

The material adopted for the models was ordinary commercial molding plaster. For models representing concrete structures, the plaster was fully air-cured; for models representing iron castings, better results were secured with green plastic plaster that had been

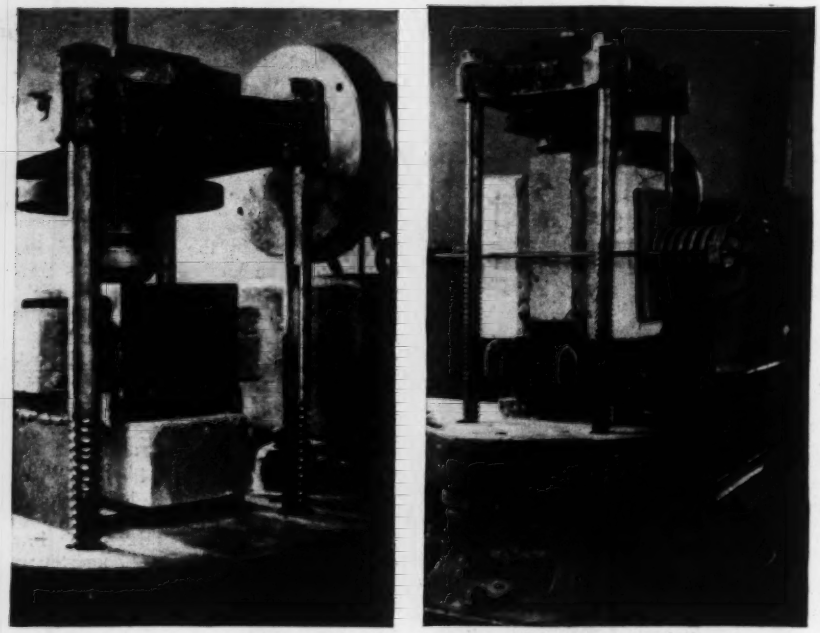


FIG. 2—TEST SET-UP in investigation of masonry mortars showing (at left) tensile bond test and (at right) shear bond test.

cured for two or three days in a moist closet. Aluminum wire was used as reinforcing in the models of concrete structures, since the ratio of its modulus of elasticity to that of plaster is about equal to the corresponding ratio for steel and concrete. To secure adequate bond, the wire was roughened by coating it with shellac and sand; and to secure a clearly defined tension failure, such as occurs when the yield point of steel reinforcement is reached, the wire was notched at intervals with a small file.

Full-scale models were made of cast-iron L-bars having various fillet radii, of plain and pierced cast-iron disks, and of a cast-iron cylinder head. Small-scale models were made of plain concrete column footings and of reinforced-concrete beams, U-frames, column footings, slabs and deck arches. Information was available, so that the predicted loads based on the model tests could be compared with the actual loads carried by the prototypes.

The strength of castings was predicted with errors of from 0 to 20 per cent, depending upon the complexity of form. The strength of reinforced-concrete structures, for which the models were from $\frac{1}{3}$ to $\frac{1}{8}$ scale, was predicted with errors of 0 to 26 per cent. In the case of the most complicated structure considered—a monolithic deck arch—the model, which was $\frac{1}{3}$ scale, indicated the strength with an error of about 15 per cent, and correctly indicated the place and manner of failure.

Mortar Joints in Brickwork—Tests of 25 reinforced brick beams and 32 reinforced brick columns made during the past three years (*Proceedings*, A.S.T.M., Vols. 33 and 34) have served to emphasize the vital importance of the integrity and strength of the mortar bond to the brick. As a consequence, a new test program has been laid out involving: (1) tests on absorption, suction rate, strength, porosity and freezing and thawing of brick; (2) tests on physical properties of cements, sands, limes and other mortar ingredients; (3) tests on mortars, to determine the loss of water by suction using Roger's apparatus, tests on flow, and test to determine the effects of wet and alternate wet- and dry-curing conditions on the strength and volume constancy of mortars; (4) tests of masonry units, to determine tensile bond and shear bond strengths of mortars.

During the past year, through cooperation of five CWA workers, over 3,000 mortar tensile test specimens, a like number of compression cubes and about a thousand prisms for volume constancy have been made; some thirty mortar mixes were used. These specimens are now being tested at regular intervals.

Most of the work that is now being done is to ascertain the factors influencing tensile-bond strength of mortars bonded to five varieties of brick used in Wisconsin (Fig. 2).

The results of the mortar bond tests thus far obtained indicate that the type of brick, the suction rate of the brick and the strength, flowability and workability of the mortar influence greatly the tensile bond strength. The necessity of wetting the brick prior to laying has been proved.

Light Steel Joists—Light-weight rolled and plate-girder sections and welded truss-type joists have been studied for load deflection and set characteristics by Prof. M. O. Withey and Instructor K. F. Wendt. The solid web types were tested under concentrated vertical and oblique loading. Shear resistance of the webs and behavior of short beams in bearing were determined. It was found that small obliquities of loading (2 or 3 deg.) had little effect on the strength or safe load when the joists were adequately restrained laterally.

The plate-girder and truss-type joists were tested under approximate uniform loading (Fig. 3). Stresses calculated from measured strains compared remarkably well with stresses determined by analysis, assuming pinned joints. (Reported in *Bulletin* 79, Engineering

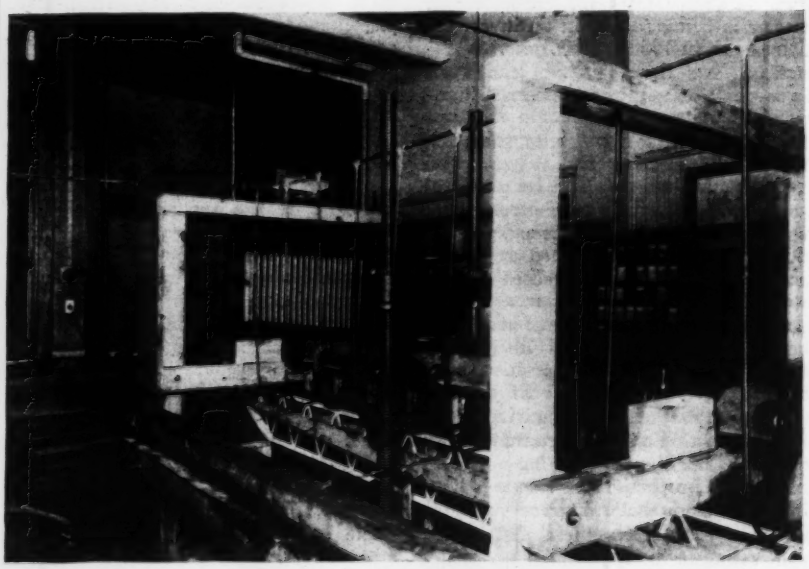


FIG. 3—TESTING an open-web floor joist under uniform loading, obtained through a series of closely spaced hydraulic jacks.

Experiment Station Series, University of Wisconsin.)

Hydraulic engineering

A half-dozen significant investigations have recently been completed or are currently under way by the department of hydraulic and sanitary engineering, under the direction of Prof. F. M. Dawson.

Air-Lift Pumping—A series of investigations has been in progress by Assistant Professor L. H. Kessler, in which appurtenances have been developed that have practical possibilities of enlarging the field of usefulness of air-lift pumping. Thus it has been found possible to make the air lift into a pump that will discharge through horizontal as well as vertical distances. A combined air separator and cyclone booster can be used to elevate fluids through a second lift a considerable distance away from the booster. It is also possible to use the air under pressure in the booster to supply a special re-lift footpiece for this second lift. The re-lift footpiece can of course be supplied with air from an independent source if this proves desirable.

Triangular Weir Coefficients — An elaborate series of precise experiments with V-notch or triangular weirs has been carried out by Instructor A. T. Lenz. The weirs tested have angles varying from 10 to 150 deg., while heads range from 0.06 ft. to 0.80 ft. Water, oils and water solutions have been tested at temperatures from 45 to 100 deg. F. The effect of viscosity and surface tension is being studied in order to determine the mathematical relations between these variables and the weir coefficients.

In order to eliminate the effect of physical variables of crest-plate materials and dimensions, brass and galvanized-iron plates of different thickness and shape have been used. The effects of oiling, greasing and painting the crest and faces of the weir have been investigated, and have been found to influence the coefficients considerably. Detailed results are not yet available.

Filter Sands—A new apparatus has been set up recently to study filter sands and filter operation. It consists of six glass tubes 5 in. in diameter and 5 ft. high, together with the necessary head tanks, gages, flow meters, etc. Preliminary investigations have been completed on two types of graded sand, and further research is in progress.

Water Hammer — An analysis comparing the theory for surges in electrical conduits with the theory for surges in fluids has been completed. Tests were made which established the validity of the theory, so long as the "negative" pressures did not go below 10 lb. per sq.in. absolute. Increased pressures at least twice the pressures in the main pipe were found in dead ends of certain lengths.

Venturi Meter Coefficients — Small venturi meters ranging in capacity from 0.1 to 10 cu.cm. per sec. and of diameters from 0.847 to 0.1817 cm. have been studied, using precise methods, to determine the effects of viscosity on coefficients. Eight different fluids were used, the lightest being gasoline and the heaviest lubricating oil. Results are not yet available.

House Plumbing — Investigations of many features found in water supply and waste-disposal systems for small houses are being carried on by Professor Dawson. Bulletin 77 of the Engineering Experiment Station, University of Wisconsin, published in 1933, considers such subjects as recommended rate of flow for various fixtures, simultaneous use of fixtures, losses in valves and fittings, and friction in various kinds of small pipes. Present work includes investigation for direct and indirect methods of heating water by oil, gas and steam, to determine the most efficient means of heating and circulating the water.

Erosion-Control Structures — Models of erosion-control structures of different scale ratios have been constructed and investigated as to their hydraulic characteristics. The types of structures have been named drop inlet, notch spillway, head flume and head spillway. The results of the tests together with all charts and tables showing recommended designs are published in Bulletin No. 80, Engineering Experiment Station, University of Wisconsin.

Sewage Sludge—A continuing investigation, initiated some three years ago, involves the subject of oxygen demand of sewage sludges. An attempt is being made to develop a better way for determining the design units to be used in activated-sludge plants with sewages of varying characteristics and behavior.

The oxygen absorbed in time units for various precentages of sludge appears to be a useful criterion as to what is likely to take place in activated-sludge plants, as other investigations have shown. The work has brought up the problem of how to test for dissolved oxygen under conditions of a bulking sludge. Some new devices and methods have been studied with good results, both under severe winter and summer conditions.

FIG. 4—APPARATUS for instruction in elementary hydraulics at the University of Wisconsin.

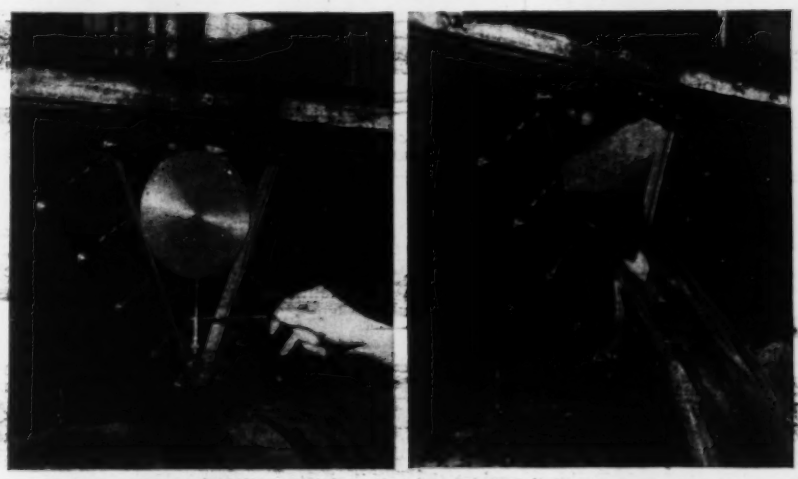


FIG. 5—TRIANGULAR WEIR used in an investigation of the effects of viscosity and surface tension on weir coefficients. Exceptional accuracy of the size of the weir angle was obtained by using the apparatus shown at the left. The right view shows the weir in operation.

F. E. TURNEAURE,
Dean, College of Mechanics and Engineering, University of Wisconsin.

Court Upsets Apportionment of Grade-Separation Costs

U. S. Supreme Court holds that changing conditions in transportation affect state laws specifying amount of cost chargeable to railroads—Police power limited in its application to facilities not primarily for safety

A DEFINITE LIMIT upon the police power of a state as it relates to the construction of grade-separation structures has been set by the U. S. Supreme Court in reversing the finding of the supreme court of the state of Tennessee in a suit brought by the Nashville, Chattanooga & St. Louis Railway to determine the constitutionality of an order for it to build and pay half the cost of a grade-separation structure. The court holds that the state in the exercise of its police power may order the separation of grades where there is need for the separation as a safety measure, assessing part of the cost against the railroad, but that it exceeds its constitutional powers when it orders a railroad to bear a large part of the cost of a separation built primarily to facilitate the movement of motor transport.

The supreme court did not say whether the railroad should bear any of the cost in the latter case. It said, indirectly, that half the cost (the amount specified by law in Tennessee) is too much under the circumstances, and sent the case back to the state court with instructions to make a finding not inconsistent with its opinion.

The court decision

The decision, in part, is as follows:

This suit, under the Uniform Declaratory Judgment Act of Tennessee, was brought on Nov. 21, 1931, in the chancery court of Davidson County, Part One, by the Nashville, Chattanooga & St. Louis Railway against the state highway commissioner and attorney general. The purpose of the suit is to secure a determination of the constitutionality of an order entered by the commission and, as so applied, of Chapter 132 of the Tennessee Acts of 1921, upon which the order rests. The statute authorizes the commission whenever a state highway crosses a railroad to require the separation of grades if in its discretion "the elimination of any such grade-crossing is necessary for the protection of persons traveling on any such highway or any such railroad"; and, without conferring upon the commission any discretion as to the proportion of the cost to be borne by the railroad, requires the latter to pay in every case one-half the total cost of the separation of grades. The order requires the railway to construct an underpass so as to separate grades where a proposed state highway will cross its main line within the limits of the little town of Lexington; and to bear one-half the cost thereof.

The railway does not question the power of the state to build the proposed highway; nor its power to require the separation of grades; nor the appropriateness of the plan adopted for such separation; nor the reasonableness of the cost—$17,400. It does not deny that if the proposed highway is built, safety of travel thereon and on the railroad will be promoted by separation of grades. It concedes that in Tennessee, as elsewhere, the rule has long been settled that, ordinarily, the state may, under its police power, impose upon a railroad the whole cost of eliminating a grade-crossing, or such part thereof, as it deems appropriate. The claim of unconstitutionality rests wholly upon the special facts here shown. The main contention is that to impose one-half the cost upon the railway, under these circumstances, is action so arbitrary and unreasonable as to deprive it of property without due process of law in violation of the fourteenth amendment.

Railroad opinion upheld

The trial court found that, with one exception, the evidence fully supported every averment of fact in the bill. It held that the order and the statute as applied, in so far as they require the railway to pay one-half the cost of the underpass, are arbitrary and unreasonable; and that they are void.

The supreme court of the state held that the statute was, upon its face, constitutional; that when it was passed the state had, in the exercise of its police power, authority to impose upon railroads one-half the cost of eliminating existing or future grade-crossings; and that the court could not any more consider "whether the provisions of the act in question have been rendered burdensome or unreasonable by changed economic and transportation conditions than it could consider changed mental attitudes to determine the constitutionality and enforceability of a statute." A rule to the contrary is settled by the decisions of this court. A statute valid as to one set of facts may be invalid as to another. A statute valid when enacted may become invalid by change in the conditions to which it is applied. The police power is subject to the constitutional limitation that it may not be exerted arbitrarily or unreasonably. Unless the evidence and the special facts relied upon were of such a nature that they could not conceivably establish that the action of the state in imposing upon the railway one-half the cost of the underpass was arbitrary and unreasonable, the supreme court obviously erred in refusing to consider them. The charge of arbitrariness is based primarily upon the revolutionary changes incident to transportation wrought in recent years by the widespread introduction of motor vehicles; the assumption by the federal government of the functions of roadbuilder; the resulting depletion of rail revenues; the change in the character, the construction and the use of highways; the change in the occasion for elimination of grade-crossings, in the purpose of such elimination, and in the chief beneficiaries thereof; and the change in the relative responsibility of the railroads and vehicles moving on the highways as elements of danger and causes of accidents. The facts specifically found, or of which the courts could take judicial notice, are these:

Police power exceeded

1. The decree of the trial court recites, as a finding upon the evidence, "that this underpass is a part of a state-wide and nation-wide plan to foster commerce by motor vehicle on the public highways, the result of which is to afford competition with railroads, and that the decision to build this underpass, its location and construction, were not in any proper sense an exercise of the police power, but rather, as set forth in the bill of complaint, pursuant to a general plan of internal improvement fostered by the Congress of the United States in conjunction with the several states to make a nation-wide system of superhighways in the interest of interstate commerce by motor vehicle, much of which is in active competition with the railroads themselves"; "that in the interest of commerce by motor vehicles on the public highways, this was a proper engineering project, properly conceived, located, designed and constructed"; but "that this underpass did not involve an exercise of the police power any more than many other features of this project, such as elimination of curves, grades, widening the pavement, et cetera."

Federal-aid highway

2. The state highways of Tennessee (as distinguished from county and city roads and turnpikes) have their origin in the federal-aid highway legislation. The aim of that legislation is "a connected system of roads for the whole nation"; "to provide complete and eco-

nomical highway transport throughout the nation"; to furnish "a new means of transportation, no less important to the country as a whole than that offered by the railroads"; to establish "lines of motor traffic in interstate commerce."

3. Federal-aid highways are designed so that motor vehicles may move thereon at a speed commonly much greater than that of railroad trains. The main purpose of grade-separation therefore is now the furtherance of uninterrupted, rapid movement by motor vehicles. In this respect, grade-separation is a desirable engineering feature comparable to removal of grades and curves, to widening the highway, to strengthening and draining it, to shortening distance, to setting up guard-rails and to bridging streams. The railroad has ceased to be the prime instrument of danger and the main cause of accidents. It is the railroad which now requires protection from dangers incident to motor transportation. Prior to the establishment of the federal-aid system, Tennessee highways were built under the direction of the county courts, and paid for out of funds raised locally by taxation or otherwise. They served, in the main, the local traffic. The long-distance traffic was served almost wholly by the railroads and the water lines. Under those conditions the occasion for separation of grades was mainly the danger incident to rail operations; and the promotion of safety was then the main purpose of grade-separation. Then, it was reasonable to impose upon the railroad a large part of the cost of eliminating grade-crossings. The effect upon the railroad of constructing federal-aid highways, like that here in question, is entirely different. They are not feeders of rail traffic. They deplete the existing rail traffic and the revenues of the railroads. Separation of grades serves to intensify the motor competition and to deplete rail traffic still further. The avoidance thereby made possible of traffic interruptions incident to crossing at grade is now of far greater importance to the highway users than it is to the railroad. For the rail operations are few, while those of motor vehicles are numerous.

Present crossing to remain

4. Lexington is a rural community of 1,823 inhabitants located in a sparsely settled territory. The construction of the new highway with the underpass was not designated to meet local transportation needs. It was undertaken to serve as a link in a nation-wide system of highways. State highway No. 20, as formerly routed, passed through Lexington on Clifton St., and crossed the railroad at grade; it was adequate for the existing traffic and that to be expected. The traffic on that highway was, and is, small. The grade-crossing has presented no serious interruption to traffic. The trains are infrequent. Only six trains are operated now each way in every 24 hours, five of them moving between 10 p.m. and 6 a.m., when there is substantially no highway travel. The grade-crossing on the old route is protected by the most modern electrical device. That the crossing is not dangerous is attested by the fact that during the ten years following Jan. 1, 1921, there were but two minor accidents, and these were settled for $50. That the present facilities are deemed locally both safe and adequate is attested by the fact that the city authorities (or any one else) have never suggesed elimination of this grade-crossing; that the grade-crossing is to remain unchanged after the new highway is put into use; and that the Clifton St. route will continue to be used for the local traffic.

5. The underpass required is for a new and additional highway over which state highway No. 20 is being rerouted, which will be a part of a federal-aid route between Nashville and Memphis, the best route between those two cities; it will connect at these termini with highways extending into other states. This highway was planned by the state highway department, acting in conjunction with the Bureau of Public Roads of the federal government. It is part of the secondary or intercounty system; but because of the expected traffic the district engineer of the bureau of roads, in recommending its approval, characterized it as a route of primary importance. Final payment of federal aid on this project was conditioned upon commencement of this underpass.

Motor-vehicle competition

6. The new highway, paralleling lines of the railway and intended for rapid-moving motor vehicles, will, through competition for both freight and passenger traffic, seriously decrease rail traffic and deplete the railway's revenue and net earnings. Practically all vehicles moving upon it will directly or indirectly compete for traffic with the railway. Buses will operate over the new highway in regular scheduled movements in the same way as passenger trains. Trucks, some of them 70 ft. in length and many weighing with load as much as 50,000 lb., operated by common carriers, by contract carrier and by private concerns, will compete for the most profitable classes of freight. The competition, besides reducing the volume of traffic, will compel reduction of rates.

The supreme court of Tennessee erred in refusing to consider whether the facts relied upon by the railway established as arbitrary and unreasonable the imposition upon it of one-half the cost of the underpass. The promotion of public convenience will not justify requiring of a railroad, any more than of others, the expenditure of money, unless it can be shown that a duty to provide the convenience rests upon it.

It is true that the police power embraces regulations designed to promote public convenience or the general welfare, and not merely those in the interset of public health, safety and morals. (*Chicago, Burlington & Quincy R.R. v. Illinois ex rel. Drainage Commissioners, 200 U. S. 561, 592.*) And it was stipulated that "in the light of modern motor-vehicular traffic anything which slows up that traffic is an inconvenience. In other words, eliminating a grade-crossing, as in the case at bar, facilitates the speed of motor-vehicular traffic, in accordance with public demands." But when particular individuals are singled out to bear the cost of advancing the public convenience, that imposition must bear some reasonable relation to the evils to be eradicated or the advantages to be secured.

It is also true that state action imposing upon a railroad the cost of eliminating a dangerous grade-crossing of an existing street may be valid, although it appears that the improvement benefits commercial highway users who make no contribution toward its cost and that a railroad has no constitutional immunity from having to contribute to the cost of safeguarding a crossing with another railway line, merely because the first railroad was built before the crossing was made; and that the state may, under some circumstances, impose upon a railroad the cost of the grade-separation for a new highway. But in every case in which this court has sustained the imposition, the new highway was an incident of the growth or development of the municipality in which it was located.

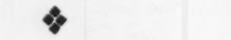
The supreme court of Tennessee did not consider whether, in view of the facts relied upon, it was arbitrary and unreasonable to impose upon the railway one-half the cost of the underpass. We have no occasion to consider now whether the facts presented by the railway were of such persuasiveness as to have required the state court to hold that the statute and order complained of are arbitrary and unreasonable. That determination should, in the first instance, be made by the state supreme court.

We have also no occasion to consider whether the railway should bear a proportion of the cost of the underpass less than one-half. The propriety of a lesser charge was not, and could not have been, considered by the commission; and it was not considered by either of the lower courts. Nor is it necessary to consider the contentions of the railway that the state action here challenged, taken in conjunction with the burdens of taxation and systems of regulation to which the railroads and their competitors are subject, amounts to a denial of equal protection of the laws; and that it discriminates against, and imposes a burden upon, interstate commerce.

The judgment of the supreme court of Tennessee is reversed, and the cause is remanded to it for further proceedings not inconsistent with this opinion.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library



Structural Analysis

THEORY OF SUPERSTATIC STRUCTURES—By J. D. Gedo. Paper; 8x11 in.; pp. 98; tables, folding diagrams. Published by the author, 205 E. 42d St., New York, N. Y. $4.50.

THE FIELD OF IMMEDIATE INTEREST in this book is limited because it is a discussion of a recondite subject—namely, the determination of stresses in what are more commonly but less accurately called "indeterminate structures." But to those who are familiar with the subject Mr. Gedo's discussion will be found of value.

Data for the Builder

WOOD STRUCTURAL DESIGN DATA—Vol. 1. By Nat'l Lumber Mfrs. Assoc. Paper, 9x11 in.; pp. 296; chiefly tables. Published by National Lumber Manufacturers Assoc., Washington, D. C. $1.

THIS FIRST VOLUME of a series of publications on wood structural-design data planned by the National Lumber Manufacturers Association brings together for the designer a mass of information that either was not available previously or was scattered through several publications. For wood beams it gives design data, maximum loads limited by deflection, and safe loads determined by bending. For wood columns it gives design data and safe loads on both dressed and rough sizes. For planks and laminated floors it gives design data and safe loads. Other data include physical, mechanical and chemical properties of wood, lumber terms, lumber quantity costs, properties and sizes of American standard yard lumber and timber, technical symbols and decimal equivalents of fractional dimensions. The book has a spiral-wire binding that permits it to lie flat when opened at any point.

A Review of Fundamentals

ELEMENTS of SPECIFICATION WRITING—By Richard Shelton Kirby. Cloth; 6x9 in.; pp. 163. Published by John Wiley & Sons, Inc., New York. $2.

CONTRACTUAL RELATIONS in construction work are based on a few fundamentals of law, fair dealing and accepted practices. In this fourth edition of a work first published in 1913 these fundamental concepts are reviewed for the benefit of students, engineers and contractors. The book goes far beyond the scope of its title in explaining sound practical relations between the owner's representative engineer and the contractor. Specification writing, as the author sees it, is far more than a mere supplement to the plan drawings—it is the preparation of a sound and fair contract document that fully protects both contractor and owner. The powers and duties of the engineer are made plain; the obligations of the contractor are well defined. From cover to cover this short book is crammed full of sound and practical advice for the preparation of specifications—advice that might well be considered by all writers of specifications who are interested in elimination of weak and foolish requirements and the inclusion of well-defined statements that spell the difference between clear sailing and a rough passage for all concerned in the construction job.

An Improvement on Impact Formulas

A MATHEMATICAL TREATISE ON VIBRATIONS IN RAILWAY BRIDGES—By C. E. Inglis. Cloth; 7x11 in.; pp. 203; line drawings and tables. The University Press, Cambridge, England; Published in U. S. A. by the Macmillan Co., New York. $7.50.

AS HIS PART of the program of the British bridge stress committee's study of impact on railroad bridges, the author of this book was assigned the task of developing a satisfactory system of mathematical analysis, to fit the dynamic effects noted in the experimental studies. The book develops in greater detail the methods outlined in the committee report and presents working formulas for dynamic deflections and the resulting bending moments and shears that take into account the natural frequency of vibration of the bridge, the oscillations set up by the "hammer blows" of the locomotive driving wheels, and the damping effect of the bridge structure itself. The author cherishes the hope that the reign of empirical impact formulas, whose only variable is span length, is coming to a close, but at the same time he pays tribute to them for forcing engineers to build with such an ample margin of strength that old bridges have been able to stand up under the unforeseen modern loadings.

Starting with a discussion of beam deflection by harmonic analysis and a consideration of natural frequencies of vibration, the book presents seven chapters on oscillations produced by various types of loads, taking into account damping and the effect of locomotive spring movement. The bridge is idealized as a girder of uniform mass on freely supported ends and the locomotive as a mass that is spring-supported on a single pair of wheels and axles. Concluding chapters on bridge and locomotive characteristics and on dynamic bending moment and shearing forces present the working formulas that are applicable to short, medium and long-span bridges.

European Housing

MODERN HOUSING—Catherine Bauer. Cloth; 6x10 in.; pp. 331; 48 pages of photographic illustrations. Published by Houghton Mifflin Co., Boston. $5.

THE TERM "modern housing" in this book is assumed to mean shelter built for efficient use over a period of years, planned in neighborhood units, with adequate light, air and open space, and costing so little that those in the lower-income classes can afford it. Modern in structure and architecture, it is most of all modern in social concept. European countries have built some 6,000,000 dwellings of "modern housing" type since the war, while not more than 10,000 have been built in the United States. Miss Bauer uses the fact of this great difference effectively in her book which, although essentially a combined analysis and history of European housing, is also an indictment of the American housing record.

With the assistance of the Carnegie Corporation, Miss Bauer, who has been associated with the architects Lewis Munford and Clarence Stein on their housing studies and work, spent considerable time in Europe studying modern housing. Her book starts with an exposition of conditions and failures in the 19th century, which finally set the stage for rather exceptional accomplishment in the post-war years. The elements of modern housing, such as location, layout and building arrangement, building types, construction and architecture, are discussed. Finally the projects and programs in each country are considered separately. The book gives an unusually complete picture of European housing failures and successes, which are bound to influence any program of social housing that the United States may be able to formulate.

Miscellaneous Notes on Booklets and Reprints

STUDIES ON COLLECTION WELLS and galleries as a source of water supply are summarized in a paper by Prof. Yashichi Yosida printed in English by the Kumamoto Technical College, Kumamoto, Japan. Much of the paper has been published from time to time in the journal of the Civil Engineering Society

of Japan. It aims to make clear some of the unknown in the subject of underground waters and to lay the foundation for further study.

A SMALL BUT UNUSUALLY COMPLETE MANUAL of instructions for concrete inspectors has been prepared by the Metropolitan Water District of Southern California for use in connection with construction of the Colorado River Aqueduct. Copies are available from the District's office in Los Angeles, Calif.

SAND-LIME BRICKS, their history and place in building work, is the subject of Special Report No. 41, Building Research, Department of Scientific and Industrial Research (Great Britain). The report brings up to date information originally published by the Building Research Station in 1921. Copies may be obtained from the British Library of Information, 270 Madison Ave., New York City. Price, 45c.

RESULTS OF EXTENSIVE LABORATORY TESTS made on a three-span reinforced-concrete arch rib resting on slender piers are given in Bulletin 269, University of Illinois Engineering Experiment Station, Urbana, Ill. Each span was 27 ft., while the piers were some 20 ft. high. The investigation was the most ambitious ever undertaken to study the behavior of multiple arches and to check the results of conventional design by the elastic theory.

CONSTRUCTION OF THE HYDRAULIC ELEMENTS at Boulder Dam, valves, gates, generators, turbines and penstocks, is the subject of a pamphlet entitled "Construction Features at Boulder Dam," published by the Bureau of Reclamation, U. S. Department of the Interior, Washington, D. C. The pamphlet is a reprint of a series of articles published in "Mechanical Engineering" from July, 1934, through December.

"ANALYSIS OF MULTIPLE-SPAN RIGID-FRAME BRIDGES" is the title of a booklet recently published by the American Institute of Steel Construction, 200 Madison Ave., New York: Prepared by J. M. Frankland, the analysis is based upon the use of the first theorem of Castigliano—namely, that the derivative with respect to one of the external forces of the strain energy so expressed is the displacement of that force in its line of action. The theorem is easily exended to cover internal forces. General equations for the multiple-span rigid frame are derived, simple cases are fully solved, and a method of solving the simultaneous equations by a process of successive approximation is presented. For comparison, the equations are also derived by slope deflection as well as by the Castigliano theorem.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

DATI CARATTERISTICI DEI CORSI D'ACQUA ITALIANI—Paper; 7x10 in.; pp. 330; maps, tables and graphs. Published by Ministero die Lavori Pubblici, Rome, Italy.

OUTLINE OF TOWN AND CITY PLANNING—By Thomas Adams. Cloth, 6x9 in.; pp. 368; foreword by Franklin D. Roosevelt. Photographs. Published by Russell Sage Foundation, New York, N. Y. $2.

THE PORTS OF NORTHERN NEW ENGLAND—Port Series No. 24. Prepared by Board of Engineers for Rivers and Harbors, War Dept. Paper, 6x9 in.; pp. 163; maps, tables. For sale by Superintendent of Documents, Washington, D. C. Price 35c.

REPORT OF THE BOARD OF WATER SUPPLY TO THE LEGISLATURE OF THE TERRITORY OF HAWAII—Paper; 6x9 in.; pp. 271; photographs, diagrams and tables. Published by Board of Water Supply, Honolulu, T. H.

Letters to the Editor

Build Dams With Material at Hand

Sir—San Gabriel Dam No. 2 of the Los Angeles County Flood Control District (*ENR*, March 7, 1935, p. 343) is having considerable unpleasant publicity, but I find no mention of the fact that the design of this dam violated one of the fundamental principles of sound engineering, that of economy resulting from the use of easily available, suitable materials. The designers of this dam went to great trouble and expense to secure a hard granite from a quarry site 2 miles up a narrow canyon from the dam site; this involved the construction of expensive roads and the added cost of a long haul. In addition, large quantities of fines were rejected which, if properly placed in the structure, would have made a solid fill less liable to settlement. Experience with this and several other large rockfill dams indicates clearly that a binder of fine material is necessary.

In the San Gabriel Canyon are frequent occurrences of a white fragile feldspar known locally as Alaskite, which is one of the constituents of granite, with just as good weathering qualities. The specifications for Dam No. 2 excluded the use of any Alaskite, notwithstanding the fact that at least half of the exposed surface of the foundation consisted of this material. Immediately above the dam site was a large ledge of pure Alaskite, sufficient in quantity and involving an average haul of about 1,000 ft. A high line would have moved most of the material at very low cost. Owing to the fragile nature of the rock, a dam built with it could have been made almost as solid as the ledge itself. Dumping, truck traffic and the use of heavy rollers would have accomplished this result. In a dam so built not only would there have been but little settlement resulting from water load, but the structure would have been almost watertight; and a much less expensive concrete facing than that used would have insured the dam against damage from seepage.

Under such conditions it is self-evident that the cost of the dam would have been much less than as built. We do not hesitate to build dams of mud, when that is the only available material. At San Gabriel No. 2 there was the opportunity of a lifetime to build a far more stable structure at low cost.

MASON D. PRATT,
Consulting Engineer.

San Francisco, Calif.,
March 14, 1935.

Less Saving than Stated

Sir—In the article on "Long-Span Bridge Development" (ENR, Oct. 25, 1934, p. 532) the following statement appeals: "As an example, it was noted that in a bridge of the Sydney Harbour type (1,650-ft. span, steel arch) each ton of extra material distributed on or in the deck required 6 tons of steel in the trusses to carry it to the foundations."

The figure given as 6 should be 0.6 tons of steel.

RALPH FREEMAN.

London, England,
Dec. 7, 1934.

Advisory Engineering Board for San Gabriel Dam

Sir—The news item in your issue of Oct. 18, 1934, p. 510, under the heading "Changes for San Gabriel Dam" refers to the Hill-Elliott-Sill-Tolman board as "appointed before the resignation of F. C. Eaton"; and again the article "San Gabriel River Flood Control" in the issue of Jan. 24, 1935, p. 116, refers to another board "appointed under the previous engineering regime to review conditions at dam No. 1."

No *reviewing* board was appointed by me; the board mentioned, of my selection, was not appointed to review conditions, but as an advisory engineering board, three members so functioning since 1931 and the fourth member since September, 1933.

During my tenure of office their advice on all engineering and geological matters was followed.

E. C. EATON.

Los Angeles, Calif.,
Feb. 7, 1935

ENGINEERING NEWS-RECORD

Volume 114, No. 13

Copyright 1935 by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard

Editorial and Publishing Offices at 330 West 42d Street, New York

March 28, 1935

Another Chapter

LAST WEEK, nearly fourteen months after approval of the Construction Code, Chapter IIC was added to the code, after being under consideration for nearly a year. Thus highway contracting is now covered, but Chapters IIA and IIB, which deal respectively with building contracting and heavy and railroad contracting, still await action after the same exasperatingly long deliberation. This striking demonstration of the slowness of the NRA system compels pause. What is wrong? Codes have done undoubted good in some industrial fields, worker and producer alike being benefited. But intolerable delays of the kind noted are destructive of everything necessary for stable industrial life. Men cannot plan when they face the uncertainty that arises from administrative procrastination added to confusion and inconsistency. Even the vision of an integrated construction industry vanishes under these conditions. In the light of the code-making delays reflected in the history of Chapters IIA, IIB and IIC of the construction code, little hope for the NRA system is in sight unless the new management just installed can bring a radical change of method. Early reform in the code handling procedure is essential if the prospect of improving the conditions of construction is to survive.

Cooperation Essential

TWO MONTHS' DEBATE has finally carried the works bill through the Senate, and the present outlook is that with little further change it will be enacted. As our news reports of recent weeks have noted, the Senate has made important improvement in the bill, but essentially it is still a blank check. Only one thing is known definitely: that it has the three-fold purpose of providing relief, work relief and public works. Relief as well as work relief are indispensable, of course, and the high importance to the recovery campaign of the specific allocations of nearly two billions to highways, grade-crossings, erosion and flood control and to non-federal projects cannot be in doubt. What now becomes important is wide cooperation and sound procedure in administration, and here the greatest danger lies in the work-relief part of the program. It is notorious that work relief has been made an avenue for wholesale evasion of local community responsibility. Cities by the score have taken advantage of federal generosity to discharge groups of employees engaged in essential work and to continue the same work by relief forces. This dodging of responsibility has increasingly shifted men from payrolls to relief lists, and incidentally from the local to the federal budget. There can be no recovery while such demoralizing action continues. A fixed policy against all evasion of the kind should be set up, and it should be rigidly enforced. Even the unprecedented fund provided by the bill cannot bring progress unless there is full cooperation on the part of the local authorities, and unless every governmental unit and every interest discharges its full duty.

The City's Opportunity

AS IF TO EMPHASIZE the opportunity for active local cooperation in the government's new relief and recovery campaign, the municipal bond market has climbed to record-breaking height. All recent issues have been absorbed hungrily by the investment community at prices that typically yield less than 3 per cent. A host of factors conspire to bring about this result: a sharpened appetite of financial institutions and trust funds for safe investment, the current unpopularity of many types of bonds, the meagerness of new municipal financing, and the absorption by the PWA of most of the municipal issues that have been put out during the past year. Add to these factors the continued absence of confidence in the safety of private obligations, and the result is a market in which cities can borrow money at almost negligible expense. Thus, conditions are exceptionally favorable for the cities to do their share in furthering the purpose of the forthcoming public-works undertaking. A healthy resumption of municipal construction at a rational rate will benefit all the far-flung elements of the economic system, absorbing millions of unemployed, stimulating the manufacture of materials and equipment, and effectively blocking the incipient decay of the physical basis of community life.

Continuous Bridges

GRADUALLY the several fears and difficulties that have surrounded the continuous bridge are being dispelled and overcome, so that this highly useful structure may receive its due consideration along with simple trusses, cantilevers, arches and suspension bridges. The general acceptance of indeterminate structures and the increased knowledge of their design and analysis on the part of American engineers have played a part in this. The computations made on the Sciotoville bridge and other continuous-truss structures, showing that appreciable pier settlements have only minor effect on stresses, increased confidence in such bridges. The comparative ease with which dead-load reactions have been determined heretofore by hydraulic jacks is now increased further by the ingenious adaptation of elastic loops or proving rings to reaction-weighing service, as discussed elsewhere in this issue. These interesting scientific instruments provide an exactness in reaction determination that is highly useful, if not altogether necessary. They are simple and rugged and thus do not require coddling, which is advantageous from the field-erection standpoint. On the jobs where they have been used they have given reactions more rapidly than would have been possible with jacks and gages. The proving ring, in facilitating erection adjustments, serves to bring the time nearer when continuous-truss bridges may be considered on their merits, without having design or construction difficulties interposed as adverse factors.

Highway Centralization

PROPOSALS to centralize all highway activities in the state highway departments are being actively discussed in Washington and California. Those who propose and oppose the change bring forward anew the arguments already made familiar in the several states of the East

that have completed or are progressing in centralization. The important fact is that those states which have made the change are showing material improvement in the condition of their local roads. On the other hand it is unfortunate, to say the least, that the legislation providing for state responsibility often did not increase the state highway income to meet the additional road construction and maintenance demand—centralization was adopted only as a device to meet demands for local property-tax relief. The Pacific Coast states that are now considering state management of all roads should plan to avoid this fundamental error, one that has proved the only drawback to full success of centralization in Eastern states. They must give the state increased highway income to meet the increased cost burden, or the effect will be to skimp main-road extension and upkeep in order to improve secondary and tertiary roads—which is bad transportation economics.

Grade-Crossing Laws Qualified

IN DECIDING a question growing out of a controversy over apportionment of the cost of a grade-separation in Tennessee, the United States Supreme Court has just laid down a clear and commendable principle. Much future grade-separation work is likely to be affected by it. In effect, the decision qualifies or amends every state law that prescribes a fixed cost division between railroad and public authority. The extent of this amendment is not yet defined, as the court did not lay down a rule for cost division, but the fact that all the pertinent state laws must be modified is established.

The Tennessee law requires that railroads bear half the cost of grade-separations ordered by the state highway commission whenever the commission finds that the separation is necessary to protect people traveling on the highway or railway. In the case in question, however, the railroad was ordered to pay half the cost of an underpass for a new and additional highway, not for an existing highway upon which dangerous conditions had developed. The Supreme Court, in the decision abstracted elsewhere in this issue, holds that the state commission would have been within its unquestioned rights had it ordered the railroad to pay half the cost of a grade-separation designed primarily to eliminate an unsafe crossing, but that it exceeded its police powers when it issued a like order for a crossing that is required not in the interest of safety so much as in the interest of speeding up movement of the railroad's direct competitors.

The significance of this ruling is at once apparent. It indicates clearly that when new superhighways are laid out the railroad's share of the cost of the grade-separation structures no longer can be determined on the basis of the general state law relating to grade-crossing elimination, but must come under a new rule. Further, this decision may be expected to stir up a large amount of court action in cases where railroads under existing laws are called upon to pay a large part of the cost of enlarging existing crossing-elimination structures to permit a conversion of a minor route into a major route. In most states test cases will have to be fought through the courts before the subject again will be back to a stage where it can be told in advance what part of the cost of such enlarged structures or of new structures on new routes must be borne by the railroads.

On the other hand, this uncertainty as to division of cost may in practice bring about assumption on the part of the states of the entire cost of crossing elimination on new trunk highways. If the latter comes to pass, the decision should facilitate the construction of such highways even though it adds to the public cost.

Housing Uncertainty

IN SPITE OF kaleidoscopic developments along the housing front, the whole picture of construction possibilities in this field remains confused. There are the PWA, the FHA, the HOLC and established mortgage lending agencies to be considered, and each is making progress, or at least recording developments week by week.

The PWA has officially stated that it will have 40,000 family units under construction during 1935, which is more than all residential units built in the entire United States during either 1932 or 1933 (the exact figures for these years, in 364 cities, are given as 28,424 and 30,697 respectively), but such an achievement requires remarkable acceleration of the $150,000,000 slum-clearance program if it is to become a fact. Just what effective use can be made of the $450,000,000 of housing money that the new work-relief bill provides is even more uncertain. Once this was said to be earmarked for rural housing, but now it is also talked of for more low-rent housing and slum clearance. It will be slow in getting into circulation, and in any event will have a tendency to arouse opposition from established private lending agencies. But if all of this subsidized housing should reach the construction stage, it would probably provide only some 150,000 residential units as against 500,000 constructed by private industry in 1929, and as against a deficit of nearly five million units that has accumulated since the decline in residential construction began.

The real hope for housing seems to lie in breaking the mortgage money jam by bold and basic reform. Constructive efforts have been made in this direction, but none has been of broad enough scope. Thus the National Housing Act in its Titles II and III, providing respectively for insured, amortized mortgages up to 80 per cent of the value of the buildings and for the establishment of local mortgage discount companies, furnishes helpful reform—at least in Title II, and perhaps in Title III—but it will be many years before the system envisioned can replace the present mortgage system. Title I of the Act, aimed to stimulate modernization loans, has done little, and the present attempt to inject new life into it by local drives and pep talks is sadly out of tune with the temper of the times. The HOLC is a nearer approach to a method of thawing frozen mortgages, but it is confined to distress mortgages only. The vast sum of money tied up in fair-to-good mortgages is still unavailable for reinvestment.

Under such conditions, the probable accomplishment in housing in 1935 is virtually impossible to predict. It seems destined to remain unpredictable until a system is devised that will thaw existing mortgages, remove fears on the part of lenders, and make loans available to borrowers at something less than usurious rates. Title II of the Housing Act goes part way in this direction, but it is too slow in getting results. The federal mortgage bank for rediscounting mortgages, proposed by real estate interests, has much to recommend it. Lower construction costs are another necessity. A new start needs to be made on housing. The present uncertainty is one of the most effective brakes now set against recovery.

CURRENT NEWS

Work Relief Bill Moves Forward After Long Delay

(Washington Correspondence)

ON Saturday, March 23, the Senate passed the Administration's work relief bill. Thus, after two months of delay, Congress is enacting the measure in a form giving President Roosevelt a practically free hand in its administration and in the expenditure of the $4,000,000,000 appropriation. The allocation of funds to various types of work is subject to a proviso which permits the President to increase any item by 20 per cent of the $4,000,000,000, or by $800,000,000, thus reducing or eliminating entirely other allocations at his discretion. This latitude is so broad as to deprive of any significance the earmarking of funds in the bill, which was a contentious issue early in its consideration.

The bill provides, however, that rivers and harbors projects, reclamation projects (except the drilling of wells, development of springs and subsurface waters), and public buildings undertaken with the new appropriation must be carried out under the direction of the regular government departments having jurisdiction of such projects. Performance of all contracts in connection with such projects would be subject to the supervision and control of the same departments.

Possible administrators

It has been reported that the following men have been selected to administer the new bill:

Secretary Ickes—In charge of public works;

R. G. Tugwell, Under-Secretary of Agriculture—In charge of the land use program;

Harry L. Hopkins, Emergency Relief Administrator—In charge of all housing activities;

Rear Admiral C. L. Peoples—In charge of supervising expenditures.

An advisory council for the works-relief set-up is also understood to be contemplated. It is said that Robert E. Wood, president of Sears, Roebuck & Co. is being considered for a place on it.

Prevailing wage issue

The prevailing wage issue was disposed of by a compromise which still gives the President authority to fix rates except on construction of permanent federal buildings, in which case the rates must be fixed in accordance with the provisions of the Bacon-Davis Act or of codes by which such rates are now determined.

The President is instructed to take full advantage of the facilities of private enterprise, wherever practicable, and an amendment urged by the master plumbers still survives which specifically requires that all sanitary plumbing work performed in connection with building construction shall be let by contract to the lowest bidder.

(Continued on p. 468)

Wilgus Resigns as Director of New York Work Relief

William J. Wilgus, director of the works division of the Emergency Relief Bureau of the City of New York, resigned on March 25 as an outgrowth of a controversy over increases in the pay of executives and employees of the works division but subsequently consented to remain in office until an aldermanic committee completes its inquiry into the city's relief operations.

In commenting upon his resignation, Col. Wilgus stated that he had been promised freedom of action—that he had made that the only condition in accepting the post. He stated that the increases were made after an exhaustive study of the staff of the organization at the time he took it over, that he considered the increases justified, and that they had been approved by the State Temporary Emergency Relief Administration and the Emergency Relief Bureau. In one case he cited an increase had been granted to a man who was doing work that had been done by two men under the old set-up.

Construction Camp Started At Pickwick Landing Dam

Construction headquarters buildings will be started soon on the Pickwick Landing Dam project of the TVA, located about 20 miles from Corinth, Miss. The camp, initially, will consist of four dormitories, fifteen permanent houses, 85 low-cost houses, the usual community buildings, a school and administration office. The camp, which will be known as Pickwick Landings Village, will have nearly four miles of streets, a sewage disposal plant, water system and other municipal facilities.

New York Port Authority Sells Bonds at High Figure

A price of 105.3983 was bid by a banking syndicate on March 25 for the $34,300,000 issue of general and refunding bonds of The Port of New York Authority. The award was made on that basis. The bonds pay interest at 4 per cent and run for a term of 40 years. The price bid represents a net interest cost of 3.73 per cent to the Port Authority. The sale is the first step in executing the Port Authority's new policy of consolidating its outstanding bonded debt of $152,000,000 into a single type of bond.

In all, 13 offers were submitted, two of which were for the entire issue.

Of the amount received through the sale of the bonds, $12,300,000 will be used to reimburse the Public Works Administration for funds advanced towards the construction of the Midtown Hudson tunnel; $2,500,000 to acquire Midtown Hudson tunnel 4 per cent notes held by the public; $10,048,000 to provide construction funds on this tunnel up to January, 1936, and $9,452,000 to acquire outstanding bonds on the Arthur Kill Bridges.

In addition to the bonds sold, bonds having a face value of $13,080,000 will be used to exchange for certain outstanding Port Authority bonds, and $5,120,000 will be held in the treasury for authorized purposes, including exchange for bonds now outstanding which from time to time may be offered for conversion.

Restrictions on new financing are embodied in the refunding program. Any new projects to be financed by special bond issues will not be taken into the consolidated account until the passing of a probationary period in which the project has demonstrated its self-liquidating abilities.

Grand Jury Alleges Conspiracy to Defraud On PWA Project in Willacy County, Texas

(Washington Correspondence)

CONSPIRACY to defraud the government in connection with an application made by the Willacy County (Texas) Water Control and Improvement District No. 1 for a combined loan and grant of $4,853,000 from the Public Works Administration is alleged in an indictment returned March 21 by a special District of Columbia grand jury naming the following men:

Charles R. Olberg, employed in Washington, D. C., by PWA from Aug. 17, 1933, to Feb. 1, 1935, as an engineer examiner on irrigation projects;

William A. Harding, of Raymondville, Texas, one of the directors of the Willacy County Water District;

Leonard C. Hammond, vice-president of the Hammond Lumber Co., San Francisco;

Harry W. Cole, vice-president of the Hammond & Little River Redwood Co., a subsidiary of the Hammond Lumber Co,. and president of the California Redwood Association;

James P. Barry, an engineer employed by the Hammond & Little River Redwood Co.;

Perry A. Welty, employed by PWA from Sept. 1, 1933, to June 1, 1934, as engineer examiner at Fort Worth, Texas;

Frank P. McElwrath, contractor and banker of Corsicana, Texas.

Object of conspiracy

The object of the conspiracy, as alleged by the indictment, was to bring about the rejection by PWA of the plans submitted by the Willacy County Water District for construction of the project by means of a gravity and open canal system, and in lieu thereof to prepare and obtain approval by PWA for a pipe pressure system according to specifications that would confine bidding, for all practical purposes, to those who were to use redwood pipe.

(Continued on p. 467)

Fifth Project In PWA Housing Plan Out For Bidding

BIDS for construction of the Indianapolis low-rent housing project undertaken by the PWA, as part of its national program of slum clearance and low-rent housing, have been invited and will be opened April 30. The Indianapolis project, for which $3,000,000 was allotted, is the fifth federal low-rent housing project to be advertised for construction bids within recent weeks. Occupying about 22 acres, it will consist of 23 apartment buildings and 96 row houses accommodating approximately 748 families.

With the land-acquisition phases of PWA's $150,000,000 slum clearance and low-rent housing program passing, the construction side of the program is speeding up rapidly, Horatio B. Hackett, Director of the Housing Division, reported to Public Works Administrator Harold L. Ickes. Bids for construction of five Federal projects have now been invited and walls are rising on one. Three limited dividend housing projects are occupied and three others are approaching completion.

Indianapolis project

Located in an area found to be the area of greatest "economic drain" in Indianapolis, the project will be one of the outstanding civic developments in the country, according to Colonel Hackett. Offering both apartments and row housing, the project comprises an adaptation of a "neighborhood plan," constituting a community within itself, with parks, gardens and recreational space surrounding the new homes.

The project occupies a former slum area which for years had been a source of concern to Indianapolis authorities. The site was occupied with old, over-crowded frame houses and shanties, with little sanitation and bad living conditions. Its proximity to the city hospital and the buildings of the University of Indiana medical center made it a civic problem.

Building arrangement

Offering a scientific approach to the proper use of space, the Indianapolis project uses an unusual arrangement of buildings. Apartments are laid out on the "chevron" plan, roughly in the form of a right angle. This arrangement permits each apartment to have a long vista of lawns and open space, including a central mall, and at the same time allows the prevailing winds of spring, summer and autumn to blow the length of the buildings, providing a maximum of fresh air for each dwelling.

The inside of the site will be kept clear of streets, utility poles and the like. Tenants in the project will have no streets to cross within the site, making the central area safe for children. Buildings will cover only 20 per cent of the site of the development the rest of the land being given over to landscaping, lawns, recreational space and play-yards.

The buildings, according to the final plans, will be simple in appearance, but carefully designed to give the maximum usable space. They will be finished in buff colored brick and the apartment buildings will be three and four stories in height. A few pent-house apartments will be provided, open on all four sides.

Soil Erosion Service Shifted To Department of Agriculture

Transfer of the Soil Erosion Service from the Interior to the Agriculture Department this week anticipates coordination of the present scattered activities in a broad program to establish control of erosion by wind and water. The transfer was made by order of Secretary Ickes, who created the new unit in his department in September, 1933, and put it in charge of H. H. Bennett, who previously had been engaged in work along similar lines in the Department of Agriculture. The extensive demonstrational program now under way has been financed by allotments from PWA totaling $20,000,000 as recurrent dust storms in the past two years have demonstrated the necessity for protecting vast areas in the Great Plains from destruction.

To what extent the Soil Erosion Service will become the nucleus for developing a unified organization of related activities has not yet been officially indicated by the Department of Agriculture. It is reported that Under Secretary of Agriculture Tugwell will be placed in charge of an extensive program of land use, embracing control of soil erosion, the retirement of submarginal lands, forestation, drainage, etc.

Various units in the Department of Agriculture now are engaged in various aspects of the land use and conservation, including the Bureau of Agricultural Engineering, the Bureau of Chemistry and Soils, the Bureau of Plant Industry and Forest Service.

IN WASHINGTON

By Paul Wooton
Washington Correspondent

Representatives of the construction industry will ask that special provision be made in the unemployment insurance bill to fit a floating industry with shifting personnel.

In the compromise which resulted in the substitution of the Russell amendment for the McCarran prevailing wage amendment to the work-relief bill President Roosevelt really made no concession. He agreed that prevailing wages would be paid on permanent federal buildings but there are no funds in the bill, after the earmarking, which could be used for that purpose.

Action of the Senate in extending the life of the Public Works Administration for two years is proof that this agency will be used in the actual administration of the new work-relief act.

Construction interests in Washington are convinced that private construction is certain to be stimulated by new phases of the federal program including: Commercial and industrial modernization made possible by the new $50,000 limit on federal housing administration loans; activities incident to title two of the housing act becoming operative; insurance of mortgages on low-cost housing; establishment of mortgage banks by the RFC and the passage of the banking bill which would make mortgage paper rediscountable.

NEW PENNSYLVANIA STATION AT NEWARK IN SERVICE

Part of the new Pennsylvania R.R. Station at Newark, N. J., was put into service on March 24. It replaces the old station a short distance to the west and is part of an extensive railroad and rapid transit terminal reconstruction program begun jointly in 1928 by the city, the Pennsylvania Railroad Co. and the Public Service Coordinated Transport. The accompanying photograph is taken from under the train shed looking out toward the new lift bridge over the Passaic River, the first of three new lift bridges to be built as part of the development. Only three tracks are being put into service at present. As the old station facilities are cleared away other tracks will be added. This will permit the elimination of the Manhattan Transfer Station east of the river, the passengers from downtown New York being brought to Newark on the Hudson & Manhattan tube trains for transfer. Ultimately the H. & M. tracks will be extended to a new station in South Newark.

The new station tracks are above the street level. At street level is the station building and below street level is the new terminal of the rapid transit line built by the city of Newark in the bed of the old Morris Canal. For a description of the latter project see *ENR*, Sept. 1, 1932, p. 243. Part of the new subway line will be opened in April.

Highway Contractors' Subchapter of Construction Code Finally Approved

ON MARCH 26 the President approved subchapter II-C of the Construction Code, the subdivision of the General Contractors' chapter for Highway Contractors. It went into effect on March 26. Two other subchapters, II-A, for Building Contractors and II-B, for Heavy Construction and Railroad Contractors, are still pending approval, the three subdivisions having been provided for in Chapter II as approved on February 17, 1934.

The Highway Contractors' subdivision by definition covers the construction of roads, streets, sidewalks, alleys, guardrails and fences, parkways, parking areas, airports, bridle paths, athletic fields, highway bridges, grade separations involving highways, light construction, sewage and waterworks improvements, excluding any such operation aggregating in its entirety less than the sum of $1,000. The total volume of business done by the industry in 1933 is reported at $456,000,000 with 473,000 employees.

Administration by committee

The subchapter will be administered by an Administrative Committee of thirteen highway contractors appointed by the Divisional Code Authority for General Contractors, eight of whom shall be members of the Associated General Contractors, which sponsored the subchapter, from nominations made by members of the Divisional Code Authority who are highway contractors. Nominations for the five non-association members may be similarly made, or made by the eight association members.

The highway subchapter prescribes certain wage and hour provisions differing from the general Construction Code. While the basic wage is 40c. per hour, and the maximum hours per week are 40, the maximum hours per week for watchmen, who are exempted from the maximum hourly provisions of the basic code, are fixed at 56 hours or 6 days per week except when housed on the work. While camp employees are not limited as to hours, they may not work more than 6 days in any week. Watchmen and camp service employees may be paid on a weekly or monthly basis, not less than the amount which they would be paid at the minimum wage rate and maximum hours for other employees. Provision is made for the employment of handicapped persons, for drafting minimum standards for safety and health for approval by NRA, as well as methods of cost finding and accounting capable of use by all members of the subdivision which will not bring about arbitrary uniformity of costs or prices.

Rules for bidding

The Administrative Committee is also empowered to prescribe rules and regulations for fair bidding practice for members of the subdivision which are to be approved by the Divisional Code Authority, the Construction Code Authority and NRA. It is also to prescribe rules requiring the highway contractor to submit the name or names of the firms with which he intends to sublet particular portions of a project when bidding on a project where he does not intend to perform at least 80 per cent of the work with his own organization. No highway contractor shall permit or require subcontractors, corporate surety or material vendors to finance his accounts unless such arrangement is expressly provided for in the original contract between the parties. The Committee shall also have the power to prescribe rules covering the renting or leasing of highway equipment by members of the subdivision.

CONCRETE WORKS STARTS ON LOCK AT BONNEVILLE DAM

Construction at upstream end of Bonneville ship lock, inside cofferdam. This excavation went 82 ft. below mean sea level. Well points were used to unwater the area during the height of the rainy season. Excavation was finished Feb. 9 and on March 15 concrete had been raised to El. —10 and —25 in gate and intake monoliths, respectively. Finished lock floor will be at El. —17. Power house structure in background.

New York Extends Committee Study of Highway Situation

THE NEW YORK Legislative Highway Survey Committee, created by the 1934 legislature to conduct an exhaustive study of all matters relating to New York's highway situation and submit recommendations for a long time program to the 1935 legislature, has been extended for another year. Under the new resolution, extending the life of the study committee, the powers of the study group have been broadened and the committee has been directed to recodify the highway law, making final report on this subject, as well as on other matters by March 1, 1936.

Partial report filed

A partial report covering progress of the committee's study during the past year was filed with the 1935 session. This progress report, up to March of the present year, indicated that no conclusions could be properly drawn until the various studies which were launched last year by other agencies co-operating with the legislative commission could be completed. Traffic studies and a "road use survey" have been prepared by the U. S. Bureau of Public Roads, the New York State Department of Public Works, and the New York State Planning Board, and it is the desire of the commission to use the findings of these several bodies in making its final recommendations.

It is also expected that a study of land classification and land use now being conducted by the department of agricultural economics at Cornell University will furnish the survey committee with valuable data pertaining to local roads. The partial report of the committee declared that the obtaining of accurate information on the volume and character of traffic on town roads, embracing over 50,000 miles, was a difficult task due to the absence of such records in the past.

The committee held ten public hearings in different sections of the state and reports the desirability of holding several more.

Trenton, N. J., Votes to Adopt City Manager Government

By a vote of 18,623 to 11,299 on March 20, the city of Trenton, N. J., became the largest municipality in that state to adopt the city manager form of government. The public interest in the question of change in municipal government is indicated by the fact that the vote was only slightly less than that cast at the general election last fall. Supporters of the existing city commission type of government carried only 8 of the 82 districts in the city. The present five commissioners forming the administrative body of the municipality will be succeeded by a municipal council of seven members to be elected at large. This council will select the city manager and fix his salary.

Candidates for the municipal council will be nominated April 16 and elected four weeks later. According to statute they will receive a salary of less than $1200 a year each.

Construction Planning Board Recommends Continuance of NRA For Two Years

AT the meeting of the National Construction Planning and Adjustment Board in Washington March 22, a resolution was adopted recommending the extension of the NRA for a period of at least two years, with provisions to strengthen and clarify the act and assure prompt and effective administration. This board, composed equally of employer and employee representatives of the construction industry, in its resolution, deplored the delay and indecision in administration of the act by NRA, but endorsed its fundamental principles and purposes. It recognized that the conditions which the act was aimed to remedy still exist in the construction industry, but that the period of operation had been too short to enable the accomplishment of the fundamental purposes. The chairman was authorized to request an opportunity to present the recommendations of the board to the appropriate committees of the Senate and House of Representatives. It is understood that the board was most concerned about the delay in stabilizing wage rates, particularly through area agreements, of which so far only some 20 have been approved, and will seek clarification and simplification of the policies and procedures necessary to more effective wage stabilization.

To prevent any injustice to members of the industry, the P. & A. Board rescinded the resolution adopted at its meeting last November, which limited the approval of applications for permission to work 48 hours per week, under conditions provided in the code, to cases where it could be shown that conditions unforeseen at the time of bidding had arisen subsequent to the award of contract. At that time it was felt that to grant a request made after the award of the contract was to grant a special privilege to one bidder and not to all, and that the right to work 48 hours should be established or denied for the benefit of all bidders prior to bidding.

Explanation No. 12 corrected

At its meeting on March 7, the executive committee of the Construction Code Authority corrected a mistake in Explanation No. 12 issued under date of May 31, 1934, which was contrary to Section 10 of Article VII, and seemed to permit the taking of new bids where previous bids had been rejected 90 days after receipt of previous bids instead of 90 days after rejection.

Indictments Allege Fraud On Texas PWA Project

(Continued from p. 464)

The indictment alleged as part of the conspiracy that Major Olberg, while employed as engineer examiner in PWA, was offered by Mr. Harding a position as consulting engineer for the Willacy District during construction of the project and was "arbitrarily and corruptly to use his influence and power by way of recommendations to his superiors" in PWA in Washington, to bring about approval of a grant and loan to the Willacy District for construction of the project by means of a pipe pressure system using redwood piping on high pressure lines.

No funds have been advanced by PWA to the Willacy District to date as the original allotment made Dec. 7, 1933, was conditioned upon subordination of $1,500,000 of bonds previously sold, which the district has not succeeded in doing.

Overt acts charged

The indictment charges the defendants with committing 28 overt acts pursuant to the alleged conspiracy. These include an exchange of telegrams between Mr. Harding and Major Olberg with reference to the offer of employment by the Willacy District. Major Olberg's reply, dated May 2, 1934, reads, as quoted in the indictment, as follows: "Will consider proposition provided I can accept without embarrassment to PWA. Will wire decision. Many thanks for consideration."

The indictment also specifies as overt acts other telegrams and letters exchanged by defendants and conferences among them on various dates, without revealing their nature.

The indictments were returned on charges submitted to the grand jury by agents of the division of investigations of the Interior Department.

Pleas in abatement were filed March 22 in the Supreme Court of the District of

Health Department Orders Buffalo Sewage Treatment Plant

An order has been issued to the city of Buffalo, N. Y., by the state department of health directing discontinuance of sewage pollution of the Niagara River and mandating the city to take the first step toward construction of a sewage-treatment plant by May 1. The order sets forth the successive step by which the city must proceed to eliminate the public nuisance and demands that complete plans and specificatio : for a sewage treatment plant be submitted for approval by April 1, 1936, the construction to be started by July 1, 1936. The treatment plant is ordered to be in operation by Oct. 1, 1937.

The state legislature has recently passed a bill empowering the city to establish a sewer authority to undertake the sewage disposal project.

The steps the city is ordered to take are as follows:

1. Engage a consulting engineer, by May 1, 1935.
2. Authorize acquiring of the site for the plant, by June 15, 1935.
3. Submit for approval detailed plans and specifications for storm relief drain, by Sept. 1, 1935, with construction to start within 60 days.
4. Submit for approval general plans for interceptors and treatment plant, by Oct. 1, 1935.
5. Submit complete plans and specifications for sewage treatment plant, by April 1, 1936, construction to be started by July 1, 1936 and operation by Oct. 1, 1937.
6. Submit a program for constructing remaining interceptors, pumping stations, force mains and storm relief sewers, by Oct. 1, 1935.

Lehigh Gives New Course In Sanitary Engineering

A new course in sanitary engineering, leading to the degree of Bachelor of Science in Sanitary Engineering is being given at Lehigh University. The technical portion of the curriculum has been constructed from courses now given in the departments of civil engineering and chemistry. In addition to basic work in these two fields, it includes geology, economics, biology, bacteriology, and non-technical electives.

EL VADO DAM WITH STEEL FACING COMPLETED ON RIO GRANDE

Storage has been started behind the El Vado Dam of the Middle Rio Grande Conservancy District in New Mexico. The structure is of gravel fill type, 180 ft. high, with a steel facing on the upstream side covering an area of 5.12 acres, electrically welded into one piece. Another feature of the dam is a steel-lined spillway channel 1,000 ft. long with a 20,000-sec.-ft. capacity.

The entire project on the Rio Grande is practically completed and has involved the construction of 160 miles of levees, 350 miles of drainage canals, 362 miles of irrigation canals with an additional 150 miles of laterals. About 29,500,000 cu.yd. of excavation work has been done in carrying out this work. Four diversion dams have been built.

This work program has been carried out as force account work by the Middle Rio Grande Conservancy District, and the construction cost is reported to be $1,400,000 under the estimate. The total cost of the project was $10,337,000. The district received a loan of $5,784,000 from the R.F.C.

Columbia on behalf of Major Olberg by Milton W. King, his attorney. Argument on the pleas will be heard by the court in the near future but the case probably will not come up for trial until the fall term.

Statement by Major Olberg

Interviewed in Washington, Major Olberg explained his relations with the Willacy District. His superior officers, he said, had advised him in May, 1934, that since PWA was reducing its forces they could see no reason why he should not accept Mr. Harding's offer to become consulting engineer on the project. Major Olberg explained that the position tendered to him was filled in August, 1934, by A. Tam, of Harlingen, Texas, and that he, Major Olberg, performed no service for the Willacy District and received no emolument whatever.

On leave from PWA in August, Major Olberg said that he went to Fort Worth at his expense and at Mr. Harding's request, accompanied him to Austin where Major Olberg appeared before an informal meeting of two members of the Texas State Water Board and defended the action of R. A. Thompson, PWA state engineer in Texas, in rejecting the original plans for the Willacy project that previously had been passed on to him from Washington. Major Olberg discussed with a third member of the water board the relative merits of various types of pipe and expressed his professional opinion that under the terms of the loan redwood pipe was superior to creosoted fir.

Following the indictment returned by the grand jury, Major Olberg made the following statement:

"This is the first time in history that an attempt has been made to prosecute an engineer for his professional opinion.

"The charge is camouflaged under the ambiguous term 'conspiracy,' into which an innocent act can be construed, but as far as the engineers are concerned, they are being prosecuted for holding honest convictions respecting the suitability of a certain material for a certain purpose. If these two engineers can be indicted and imprisoned for their professional opinion, every other engineer lives under the shadow of the same threat, and for self protection if nothing else should be vitally interested in the persecution that is now taking place under the guise of justice.

"In the course of my work I passed favorably on the application for a loan for the Willacy project. In compliance with my duty I pointed out to the applicant where in my opinion several improvements could be made in the design. Willacy was one of several irrigation projects applying for a loan in the Rio Grande valley. It was a partly constructed project and desired the loan to complete it, using a large number of pumping plants and open ditches.

"The Willacy project has a water right to 5,000 sec.-ft. of the flood flow of the Rio Grande while the design submitted provided for pumping only about 600 sec.-ft. from the river and storing it in a small reservoir located near the center of the project from which it must be pumped by successive lifts to the irrigable land. Pump diversion seemed absurd, except as an insurance, since during the time the project was entitled to water it would flow by gravity from the river to the reservoir. The project, however, received favorable consideration by the engineering division in Washington since it was fundamentally sound. The application was then sent to the PWA state engineer at Fort Worth, where the design was rejected and the Willacy district required to submit a new design."

Charles R. Olberg began his professional engineering career in the federal government service in 1894 and his last position was assistant chief engineer of the United States Indian Irrigation Service from 1919-29. The outstanding feature of his work for the Indian Service was the design of the Coolidge multiple-dome dam. Major Olberg was consulting engineer to the Soviet Government on hydraulic problems from 1929-33.

Work Relief Bill Passes Senate After Weeks of Delay

(Continued from p. 464)

Present practice is specified for the allocation of road funds among the states and the bill makes possible a program of highway construction on a larger scale than ever before. All but a very insignificant portion of the $800,000,000 earmarked for highways will be used for the payment of work done under contract. It is probable that one force account project will be maintained for comparative purposes in each state. The work will be done through the state highway commissions, as usual. The President will indicate what portion of the total allocation will be used for grade crossing separation. There is reason to believe that he will order $300,000,000 used for that purpose. At the last session of Congress $200,000,000 was authorized for highways but only half of the amount was appropriated. To cover that commitment $100,000,000 of the work-relief funds will be allotted. Under the law not less than 25 per cent of the money to be used for road construction must be devoted to feeder roads outside the federal-aid system.

Grade crossing elimination

The grade-crossing funds will be allocated with respect to the population, railroad mileage and road system mileage of the states. Population is to have a weight of 50 per cent and the two other categories 25 per cent each. For the past several months the highway departments have been cooperating with the railroads in the preparation of plans so that most of the states are ready to absorb their full allotment of grade crossing money.

All of the money carried by the bill is to be available immediately upon its approval. To a special board will be assigned the responsibility of securing the most rapid possible expenditure of the fund. This is on the theory that velocity in the expenditure of this fund is essential to rapid recovery.

The $4,000,000,000 fund is protected from dissipation which diverted a large part of the original appropriation of $3,300,000,000 in 1933, by a provision in the new law that no funds may be expended for the administrative expenses of a government department or agency ordinarily financed by annual appropriations unless additional work is imposed on them in carrying out the work relief program. Any part of the fund may, however, be used, in the President's discretion for administration of the Agricultural Adjustment Administration during the next 12 months.

Washington Enacts Licensing Law Covering Engineers and Surveyors

An act governing the practice of engineering and land surveying in the state of Washington was passed by the legislature during its recent session and signed by the governor March 22. It will take effect 90 days after the adjournment of the legislature or about June 15. The act includes the practice of civil, electrical, mechanical, structural and hydraulic engineering and land surveying.

The act does not include mining engineers as this group had requested that their branch of the profession be excluded. However, the act as passed exempts the members of the American Institute of Mining and Metallurgical Engineers from registration. A member of the legislature insisted that the law include this exemption although mining engineers were exempted, as a group, from the requirements of the bill. The governor refused to veto this clause exempting the members of the Institute from registration although they were already exempted as mining engineers. As a result, the provisions of the bill will allow any engineer who is able to join the American Institute of Mining and Metallurgical Engineers to be exempt from the provisions of the act. This peculiar inclusion in the bill makes it unusual when compared with the usual regulatory act.

SOCIETY CALENDAR

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., May 2 and 3.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

SOUTHEASTERN SECTION, American Water Works Association, Birmingham, Ala., April 2-3.

ILLINOIS SECTION, American Water Works Association, Springfield, April 10-11.

MONTANA SECTION, American Water Works Association, Helena, April 10-11.

PENNSYLVANIA WATER WORKS OPERATORS' ASSOCIATION, annual meeting, State College, June 26-28.

Personals

JAMES E. LOER, formerly a project engineer of the Indiana highway department, was recently appointed junior assistant city engineer by the Indianapolis board of public works, succeeding Carl F. Kortepeter.

FREDERICK K. WING of Buffalo, N. Y., has been appointed engineer for the Niagara Frontier Planning Board, which is seeking federal aid for a $200,000,000 improvement program for the Niagara Frontier.

J. W. B. BLACKMAN recently was appointed city engineer-director of public service of Long Beach, Calif., succeeding the late Edward H. Harnett. To accept this appointment, Mr. Blackman resigned as engineer and manager of the Pan-Pacific Piling & Construction Co., with which he has been connected for the past seven years.

JOHN H. BOLTON, former president of the New York State Highway Chapter, Associated General Contractors of America, HARRY J. SUITS, HARRY BOLTON and J. LYNN GIBBS, for the past eight years associated in highway contracting work under the firm name of Bolton, Suits, Bolton & Gibbs, Watkins Glen, N. Y., have dissolved the partnership. John H. Bolton will continue in the highway business as an individual.

Obituary

GEORGE F. BOWLUS, age 55, an engineer with the Minnesota state highway department for 13 years died March 20 at his home in St. Paul.

THOMAS J. LOCKE, district engineer of the Department of Public Works, Canada, died at Halifax, N. S., on March 21. Mr. Locke had been associated with the department for over thirty years and was widely known in the Maritime Provinces.

HENRY L. CONNELL, construction engineer and a member of the New York City Board of Standards and Appeals since 1925, died March 25 after an illness of two years. Mr. Connell had an important part in the building of the Fire Island Sewer system, the city subway and the Ashokan Dam of the city's water supply. He was formerly president of the Tunnel Construction Co.

CHARLES JOHN PIGOT, well-known railway builder and engineer died at Quebec on March 13. One of the builders of the Lake St. John Railway, he came to Quebec from Ceylon in 1890 to take over the duties of assistant engineer in charge of the construction of the Lake St. John Road, now part of the C.N.R. Later Mr. Pigot was attached to the Quebec Power Company, acting in a consulting capacity as engineer of maintenance-of-way and structures for its extensive properties.

CHARLES A. MCKENNEY, consulting engineer, died this week in Washington after several months' illness. After graduation from Princeton in 1892, with the first class ever to complete the sanitary engineering course, Mr. McKenney served several years with a District Engineer office, U. S. Engineers, resigning to accept a War Department commission to remodel the water and sewage system at Fort Monroe, Va. During the World War, he was appointed a major in the Engineer Corps and served with the War Industries Board in Washington. He was advanced to the rank of colonel before his discharge. Mr. McKenney later helped organize the consulting engineering firm of Black, McKenney & Stewart, which was dissolved in 1930. Since that time he had engaged in extensive engineering operations in South America, notably river-widening work in Colombia and surveying for power sites in the Andes. Just before his retirement from active work, Mr. McKenney completed an extensive survey of Georgia inland waterways for the state government.

CONSTRUCTION STATISTICS OF THE WEEK

LOW PUBLIC AWARDS pull this week's construction volume down to $18,584,000. Of this amount, $4,623,000 for private work compares with $4,858,000 last week, and $13,961,000 for public awards compares with $16,996,000 a week ago. Federal awards are higher than last week, $2,035,000 compared with $1,882,000 while a large loss is recorded in state and municipal awards, $11,926,000 compared with $15,114,000 last week.

Bridge awards are highest for the year at $3,991,000 for public bridges and $196,000 for private bridge construction. Waterworks are low at $865,000 and sewerage, at $515,000. Industrial buildings at $977,000 are lower than last week while commercial buildings at $2,183,000 show a substantial gain. Public buildings at $2,435,000 are less than half of last week's total. Highways are lower at $4,061,000. Earthwork, irrigation and waterways awards are up to $1,555,000.

The larger awards include highway lettings by Louisiana, $782,000 and by Ohio, $418,000. The high bridge total is due to the award of steel work, suspended spans and approach viaduct for Triborough Bridge, New York, $3,114,000. In Nebraska, the Platte Valley Public Power and Irrigation Dist., North Platte, let contracts for under river crossings for Sunderland Project, $438,000 and for 1,881,300 lb. aluminum wire, $340,000.

New capital for the week consists of $5,966,000 in state and municipal bond sales.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1934	Prev. 4 Weeks	Week Mar. 28 1935
Federal Government	$9,000	$3,357	$2,035
State and municipal	13,413	14,871	11,926
Total public	$22,413	$18,228	$13,961
Total private	7,028	5,556	4,623
Week's total	$29,441	$23,784	$18,584
Cumulative to date: 1934	$385,046,000	1935	$307,311,000

CORRECTION: Deduct $787,000 from State and Municipal Awards reported last week to adjust for one contract rescinded after award and one corrected as to amount.

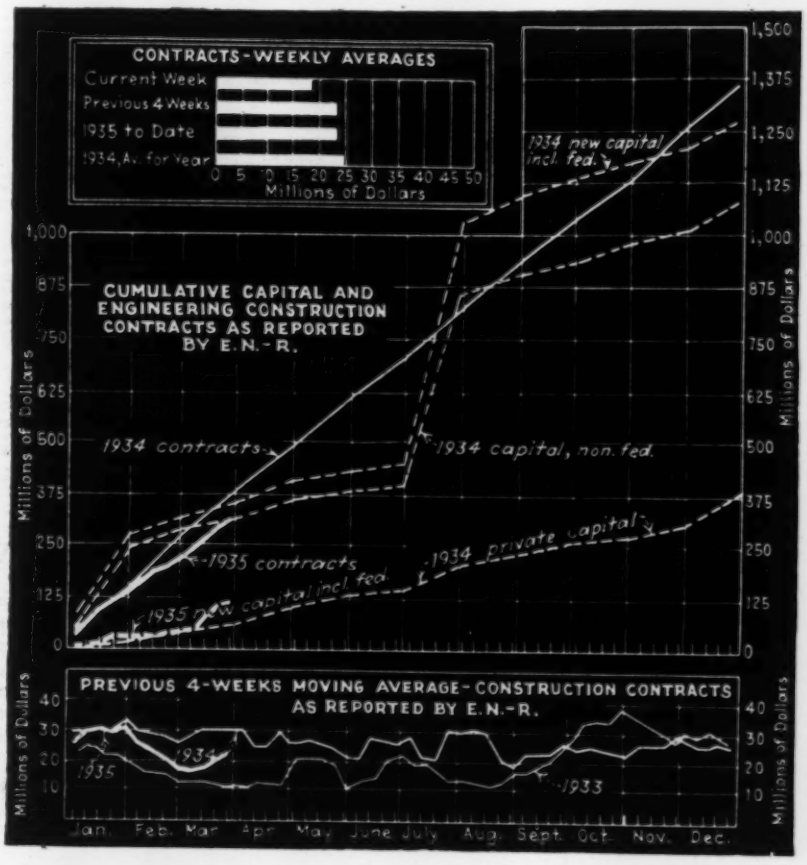
NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1935	Week Mar. 28	Cumulative
State and municipal	$5,966	$110,366
PWA allotment, S&M	....	—33,404
RFC loans, S&M	....	84
Corporate issues	....	....
PWA allotments, private	....	....
Total, Non-Federal	$5,966	$84,355
PWA allotments, Federal Constr.	....	8,270
Total new capital	$5,966	$92,625
Cumulative to date: 1934	$356,808,000	1935	$92,625,000

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
Mar., 1935	193.46	93.00	Feb., 1935	76	33
Feb., 1935	196.02	95.52	Jan., 1935	130	57
Mar., 1934	194.06	93.20	Feb., 1934	116	51
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56



Current Construction Unit Prices

Concrete Highway Bridge at Carlton, Wash.

CONSTRUCTION is underway on a 439-ft. seven-span reinforced concrete girder type bridge over the Methow River at Carlton, Wash., contract being awarded by State Highway Director L. V. Murrow in January, 1935. Span lengths vary from 50 to 93 ft., with a 24-ft. roadway width and a 3½-ft. sidewalk. Spans are designed as continuous except for one span which is supported at ends. Contract also includes the construction and surfacing with crushed stone of 0.7 miles of approach. Completion is scheduled for July 1, 1935. Eleven bids ranged from $57,954 to $76,553. Unit prices follow of the three low bidders with their respective totals: (A) Henry Hagman, Cashmere, Wash. (contract), $57,954; (B) Sather & Sons, Seattle, Wash., $61,851; (C) Colonial Construction Co., Spokane, Wash., $63,466.

METHOW RIVER BRIDGE AND APPROACHES.

	A	B	C
1. Clear and grub—lump sum	$200.00	$100.00	$400.00
2. Excavation, Cl. A, 600 ft. haul—11,780 cu.yd.	0.34	0.30	0.30
3. Excavation, solid rock, 600 ft. haul—1,230 cu.yd.	0.80	1.00	0.85
4. Excavation, structure, 600 ft. haul—80 cu.yd.	1.00	1.00	1.00
5. Excavation, Cl. D, 600 ft. haul—120 cu.yd.	1.00	1.00	0.60
6. Overhaul on above materials—7,360 sta.yd.	0.03	0.02	0.02
7. Overhaul on above materials and filler—4,780 cu.yd. miles	0.20	0.125	0.20
8. Slope treatment—5,100 lin.ft.	0.15	0.10	0.15
9. Crushed stone surface, spec. top, in place—660 cu.yd.	1.90	1.75	2.00
10. Crushed stone surface, base, in place—1,280 cu.yd.	1.90	1.75	2.00
11. Filler in place (except haul)—390 cu.yd.	0.50	1.00	0.50
12. Water in place on roadway—30 M gals.	3.00	1.50	3.00
13. Reinf. concrete R/W markers in place—30, each	2.00	2.50	2.50
14. Special open wood flume, Design 1, in place—900 l.f.	0.65	0.75	0.60
15. Special open wood flume, Design 2, in place—380 l.f.	1.00	1.00	0.90
16. Welded steel irrigation pipe, 16 gauge, 12 in. dia.—115 l.f.	0.90	3.00	2.50
17. Heavy loose riprap in place—650 cu.yd.	1.75	3.00	2.00
18. Plain concrete or v.c. pipe, 12 in. dia.—301 l.f.	1.25	1.50	2.00
19. Plain concrete or v.c. pipe, 18 in. dia.—421 l.f.	1.75	2.25	2.50
Continuous reinf. concrete deck girder bridge:			
1. Structure excavation—750 cu.yd.	6.00	6.00	5.00
2. Concrete, Cl. A, in place—716 cu.yd.	22.00	25.00	25.00
3. Concrete, Cl. B, in place—290 cu.yd.	22.00	23.00	25.00
4. Concrete, Cl. D, in place—130 cu.yd.	18.00	23.00	25.00
5. Steel reinforcing bars in place—218,000 lb.	0.0475	0.05	0.05
6. Copper seals in place—46 lb.	0.90	0.60	1.00
7. Bronze expansion plates—1,030 lb.	0.60	0.60	0.70
8. Furnish untreated piles at site—3,850 l.f.	0.18	0.12	0.20
9. Drive piles—154, each	8.00	10.00	15.00
10. Precast concrete piles, in place—480 l.f.	4.00	4.00	4.00
11. Drive test piles in place—4, each	30.00	25.00	40.00
12. 3 in. red bull's eye reflectors, in place—2, each	12.00	5.00	7.50
13. Remove existing bridge—lump sum	300.00	500.00	600.00

N.Y.C.R.R. Track Depression, New York City

AS ANOTHER step in the $200,000,000 program of eliminating the New York Central's freight tracks from the streets of the west side of New York City, a contract was let late in January, 1935, for a railroad cut and overhead bridges carrying the cross-streets from West 42 St. to West 53rd St. The cut, with subgrade about 25 ft. below street level, runs through private property midway between Tenth and Eleventh Avenues. Alternate bids were taken on excavation for disposal along the Hudson River waterfront in designated park areas or disposal as the contractor desired otherwise. Contract was awarded on the basis of disposal in the park areas. There was a spread of 100 per cent between low and high of the fourteen bidders. Bids for park disposal ranged from $1,038,462 to $2,069,492; those for contractor disposal ran from 7 to 10 per cent higher. Contract was let by the railroad company, though the state and city participate in the expense. Demolition of most of the buildings was done under a previous contract. J. W. Pfau, chief engineer of the New York Central lines, will be in charge. Following are complete unit prices of the three low bidders; (A) P. T. Cox Contracting Co., New York (contract) $1,038,462; (B) Rosoff Subway Const. Co., New York, $1,051,668; (C) Geo. H. Flinn Corp., New York, $1,058,446.

NEW YORK CENTRAL R.R. TRACK DEPRESSION

	A	B	C
1. Rock excavation, dispsl. park area—130,120 cu.yd.	$3.20	$3.20	$2.64
1a. Rock exc. dispsl. by contractor—130,120 cu.yd.	3.70	3.50	3.14
2. Unclassified exc. dispsl. park area—73,800 cu.yd.	1.25	1.60	1.63
2a. Unclassified exc. dispsl. by contractor—73,800 cu.yd.	1.60	1.90	2.03
3. Coarse sand fill, superstruct.—300 cu.yd.	2.50	2.50	2.05
4. Roadway grading—1,200 cu.yd.	5.00	.25	4.14
5. Furnish, instal, maintain, remov. deck—75,000 S.F.	.60	1.00	1.21
6. Maintain and remove bridge—1,200 S.F.	1.00	.30	.78
7. C.I. waterpipe, appurt., 6 in.—1400 L.F.	1.00	1.00	.75
8. C.I. water pipe, appurt. 12 in.—700 L.F.	1.50	2.00	1.73
9. C.I. hub and spigot, str. pipe—45 tons.	65.00	60.00	57.20
10. C.I. hub and spigot, specials—24 tons.	150.00	135.00	131.20
11. Steel pipe, 12-in.—1,050 L.F.	10.00	6.50	7.89
12. Service connections—10.	25.00	50.00	67.50
13. Relocate hydrants—4.	50.00	70.00	110.00
14. Concrete masonry, CL.B.—3,255 cu.yd.	12.50	10.50	10.24
15. Concrete masonry, CL.C.—1,070 cu.yd.	10.00	10.00	8.51
16. Concrete pav. fdt., CL.C.—1,030 cu.yd.	6.00	7.00	6.79
17. Cement mortar surfacing, 1:3—500 S.F.	.25	.10	.22
18. Portland cement—61,100 bags	.65	.60	.60
19. Reinforcing rods—142,200 lb.	.045	.05	.0575
20. Reinforcing mesh—22,000 lb.	.10	.10	.105
21. Anchor bolts—7,100 lb.	.10	.10	.085
22. Granite curb 6 in.x 16 in.—2,400 l.f.	2.20	2.00	2.10
23. Old curb—200 l.f.	1.00	1.00	1.50
24. Granite headers 6 in.x 12 in.—900 l.f.	1.00	1.40	1.00
25. Concrete sidewalks—26,160 sq.ft.	.20	.25	.24
26. Relay flag sidewalks—4,000 sq.ft.	.10	.10	.10
27. Relay stone block pavement—500 sq.yd.	1.35	1.50	2.50
28. Restore asphalt pavement—1,000 sq.yd.	2.25	1.50	1.50
29. Granite block pavement—3,600 sq.yd.	5.75	5.50	5.10
30. Alter manholes—12.	35.00	30.00	22.00
31. Alter catch basin—1.	75.00	50.00	55.00
32. Reinf. conc. pipe, 12 in.—1,450 l.f.	2.00	2.00	1.45
33. Reinf. conc. pipe, 18x20½ in.—1,560 l.f.	4.00	4.00	2.80
34. Reinf. conc. pipe, 24x27 in.—100 l.f.	4.50	6.00	4.20
35. Brick manholes, R.R. cut—13.	60.00	70.00	85.20
36. Catch basins, R.R. cut—19.	75.00	55.00	65.30
37. Catch basins, type A—2.	175.00	50.00	100.00
38. Drainage basins, R.R. cut—46.	50.00	30.00	47.70
39. Perforated drain pipe, 10 in.—5,700 l.f.	1.50	1.50	1.13
40. Waterpfg. emulsion—300 squares.	3.00	3.00	3.00
41. Dry Rubble masonry—1,000 cu.yd.	7.50	3.50	12.00
42. Fibre ducts, 3½ in.—14,600 l.f.	0.175	.20	.21
43. W. I. pipe, 3½ in.—2,000 l.f.	1.15	1.00	.92
44. W.I. pipe, 1½ in.—421 l.f.	2.00	2.00	.40
45. Splicing chambers—11.	85.00	45.00	126.25
46. Special splicing chbr.—1.	200.00	100.00	165.00
47. Chain link fence—830 l.f.	1.40	1.40	1.40
48. End posts in place—78.	9.00	9.00	11.50
49. Gates, 12 ft.—7.	85.00	67.00	109.00
50. Gates, 4 ft.—2.	40.00	22.00	62.75
51. Underpin bldg., W. 42nd St.—one.	5,000.00	5,000.00	4,900.00
52. Struct. steel delivered—3,429,000 lb.	0.03	0.0305	0.0369
53. Erect steel superstructure—lump sum.	25,000.00	17,000.00	33,800.00
54. Concrete superstructure—lump sum.	90,000.00	70,000.00	82,400.00
55. Gunite fences—6,686 sq.ft.	1.00	1.00	.91
56. Gunite encasing beams—14,200 sq.ft.	.40	.60	.43
57. Gunite walls, 49th St.—2,640 cu.ft.	1.50	1.20	1.57
58. Membrane—85,300 sq.ft.	.07	.07	.066
59. Asphalt block protection course—3,150 sq.ft.	.18	.25	.164
60. Stone block gutters—30 sq.yd.	3.00	1.50	1.70
61. Temporary fence—200 l.f.	2.00	2.50	2.20
62. Lead flashing—72 sq.ft.	1.00	2.50	2.20
63. Rubble for blind drains—100 cu.yd.	3.00	5.00	5.30
64. Demolish bldgs.—West 41, 42 and 49 Sts.	27,500.00	33,000.00	36,800.00

Deer Creek Water Project, Shawnee, Okla.

FOUR CONTRACTS were awarded Dec. 10, 1934, for the construction of the new Deer Creek water supply system for Shawnee, Okla. The project includes an earth dam, 5½ miles of 27-in. and 3 miles of 20-in. conduit, filter plant, pumping station and mains. The clearing of the lake site (Sec. 1 of the specifications) is to be awarded later. Alternate bids were taken on the pipe lines for cast iron, steel and reinforced concrete. Concrete was selected for the 27-in. lines and steel for the 20-in. pipe. Eight bids on the dam ranged from $166,310 to $190,650; three on the concrete pipe from $152,365 to $156,415; and eleven on the

steel pipe from $65,263 to $79,450. On the filter plant and pumping station eight bids were unusually close, varying from $105,747 to $113,822. The following tables show the total and unit bids of the three low bidders. W. R. Holway, Tulsa, is engineer.

TOTAL BIDS, DEER CREEK WATER PROJECT, SHAWNEE, OKLA.

Section II—Dams, Roads and Bridge:	
A—F. T. Odell, Hannibal, Mo. (contract)	$166,310.00
B—Kadane Const. Co., Frederick, Okla	169,260.00
C—J. Harrison, Lindsay, Okla	176,150.00
Section III—27 in. Pipe Line (Reinf. Conc.):	
D—Hill and Evans, Fort Smith, Ark. (contract)	$152,365.00
E—Lock Joint Pipe Co., Ampere, N. J	153,455.00
F—M. E. Gillioz, Monett, Mo	156,415.00
Section IV—20 in. Pipe Line (Steel):	
G—B & M Const. Co., Oklahoma City (contract)	$65,263.00
H—C. F. Lytle Co., Sioux City, Ia	66,805.00
J—J. A. Tobin, Kansas City, Kan	67,482.00
Section V—Filter Plant, Pump Station and Mains:	
K—Hill and Evans, Fort Smith, Ark. (contract)	$105,747.50
L—J. A. Tobin, Kansas City, Kan	106,003.50
M—Ulen Const. Co., Chicago, Ill	108,977.00

UNIT PRICES DEER CREEK WATER PROJECT, SHAWNEE, OKLA.

Item	Quantity	Unit Bids		
Section II—Dams, Roads and Bridge		A	B	C
1. Clear and grub dam site (lump sum)		$200.00	$200.00	$500.00
2. Earth exc., corewall and conduit	20,000 cu.yd	.18	.30	.20
3. Sandstone exc. in trench	600 cu.yd.	2.00	2.00	1.00
4. Clay puddle refill	22,000 cu.yd	.18	.20	.25
5. Earth embankment	450,000 cu.yd.	.17	.18	.17
6. Rock riprap—class A	30,000 sq.yd.	.64	.50	.50
7. Rock riprap—class B	500 cu.yd.	1.50	1.50	.60
8. Sandstone exc. in spillway	20,000 cu.yd	.50	.25	.40
9. Shale exc. in spillway	2,000 cu.yd.	.40	.20	.30
10. Rock riprap hauled in	2,000 cu.yd.	.85	.50	1.75
11. Concrete, class A	200 cu.yd.	15.00	16.00	15.00
12. Concrete, class B	100 cu.yd.	14.50	17.00	12.00
13. Concrete, class C	750 cu.yd.	10.00	10.00	11.00
14. Reinforcing steel	35,000 lb.	.04	.04	.05
15. Wood sheet piling left in place	16,000 sq.ft.	.10	.04	.50
16. Bridge superstructure (lump sum)		10,450.00	15,750.00	9,600.00
17. Intake tower and outlet works (lump sum)		12,000.00	11,870.00	14,000.00
18. Road construction (lump sum)		4,500.00	5,000.00	8,600.00
19. Grassing and cleaning up (lump sum)		1,500.00	1,250.00	1,000.00
20. Concrete guard rail	5,000 lin.ft.	1.00	1.20	1.25
Section III—Pipe Line, 27-in.		D	E	F
1 (a). 27-in. C.I. pipe incldg. earth exc.	29,500 lin.ft	$7.50	.....	.....
1 (b). 27-in. steel pipe incldg. earth exc.	29,500 lin.ft	5.50	.....	.....
1 (c). 27-in. reinf. conc. pipe incldg. earth exc.	29,500 lin.ft	5.12*	$5.15	$5.25
2. Rock excavation	300 cu.yd.	2.00	2.50	3.00
3. Blow-offs and air valves	(lump sum)	425.00	580.00	400.00
4. Concrete	20 cu.yds.	15.00	10.00	12.00
*Contract.				
Section III—Pipe Line, 20 in.		G	H	J
1 (a). 20-in. C.I. pipe incldg. earth exc.	16,500 lin.ft	.....	$3.97	$4.65
1 (b). 20-in. steel pipe incldg. earth exc.	16,500 lin.ft	3.35*	3.42	3.355
1 (c). 20-in. reinf. concrete pipe incldg. earth exc.	16,500 lin.ft	.....	.....	.....
2. Rock excavation	200 cu.yd	2.50	2.50	1.00
3. Canadian River crossing	1,500 lin. ft. (lump sum)	6,800.00	7,500.00	8,725.00
4. Connections, blowoffs, air valves	(lump sum)	888.00	1,175.00	1,400.00
5. Concrete	100 cu.yds.	18.00	12.00	18.00
*Contract.				
Section IV—Filter Plant Pump Stations and Mains		K	L	M
1. Earth excavation	7,500 cu.yd	$0.50	$0.62	$0.70
2. Rock excavation	1,250 cu.yd.	1.00	1.40	1.20
3. Take out old concrete	150 cu.yd.	4.00	2.75	8.00
4. Concrete, class A	340 cu.yd.	18.50	19.70	22.00
5. Concrete, class B	750 cu.yd.	15.25	16.00	16.00
6. Concrete, class C	100 cu.yd.	13.00	11.30	12.00
7. Reinforcing steel	100,000 lb.	.045	.049	.045
8. Wash water tank	(lump sum)	1,800.00	3,000.00	3,300.00
9. Chemical feed equipment	(lump sum)	6,250.00	5,500.00	5,170.00
10. Mechanical mixers	(lump sum)	2,500.00	2,480.00	2,260.00
11. Venturi meters	(lump sum)	3,000.00	2,700.00	2,800.00
12. Basin level control	(lump sum)	700.00	600.00	510.00
13. Filter equipment, piping, valves	(lump sum)	15,750.00	13,275.00	14,040.00
14. Pumps, piping, valves	(lump sum)	5,250.00	4,100.00	5,286.00
15. Outside piping, valves, sluice gates	(lump sum)	8,500.00	7,800.00	7,676.00
16. Buildings	(lump sum)	9,800.00	17,200.00	14,390.00
17. Electrical work	(lump sum)	2,560.00	2,175.00	2,440.00
18. 14-in. C.I. main and excavation	3,000 lin.ft	4.60	3.37	3.86
19. 10-in. C.I. main and excavation	1,650 lin.ft	3.40	2.22	2.76
20. Miscellaneous	(lump sum)	1,100.00	1,860.00	1,841.00

Steel Cost Under Concrete for Viaduct

CONSTRUCTION of the new 1,930-ft. viaduct by the Iowa State Highway Commission over the Des Moines River and parallel railway tracks at Ottumwa gives comparable costs on reinforced concrete and structural steel designs to the advantage of the latter type which cost approximately 16 per cent less. Contract was awarded in February, 1935, for a steel structure consisting of nine continuous steel deck trusses, one reinforced concrete deck girder, nine steel plate girder spans and a reinforced concrete approach. The concrete alternative consisted of eight reinforced concrete arches, one reinforced concrete deck girder, nine steel plate girder spans encased in gunite and a reinforced concrete approach structure. Both designs provided for a 32-ft. roadway and two 5-ft. sidewalks. Comparison follows showing the quantities, unit prices and total bids of the low bidders for each class. For steel construction: (A) Wisconsin Bridge & Iron Co., Milwaukee, Wis. (contract) $303,005. For concrete construction: (B) Snyder & Johnson, Inc. and Weldon Bros., Humboldt and Iowa Falls, Ia., $360,120.

COST COMPARISON FOR STEEL AND CONCRETE VIADUCT DESIGN

Item	Steel Design Quan.	Steel Design A	Concrete Design Quan.	Concrete Design B
1. Concrete masonry, cu.yd	5,036	$17.50	11,191	$17.00
2. Reinforcing steel, lb	560,030	.033	1,431,041	.0367
3. Structural steel, lb	3,051,644	.0485	1,158,061	.0475
4. Steel railing, lb	197,916	.074	111,255	.08
5. Steel stairs, lb	49,469	.0824	55,363	.09
6. Steel piling, lin.ft	4,400	1.73	8,175	1.60
7. Treated wood piling, lin.ft	2,648	1.165	2,616	1.00
8. Excav., Cl. I, cu.yd	2,723	1.80	3,941	1.00
9. Excav., Cl. II, earth, cu.yd	629	4.00	1,243	5.00
10. Excav., Cl. II, rock, cu.yd	835	7.30	810	5.00
11. Gunite, regular finish, sq.ft	.....	.....	43,421	.25
12. Gunite, special finish, sq.ft	.....	.....	6,302	.30
13. Stone masonry and riprap, cu.yd	50	3.00	50	8.00
14. Lighting, lump sum	.....	4,000.00	.....	5,000.00
15. Building equipment, lump sum	.....	700.00	.....	1,000.00
16. Rebuild sewer outlet, lump sum	.....	600.00	.....	400.00

Spur Dikes and Mattresses, Lower Mississippi

SPUR dikes and willow mattresses forming part of the lower Mississippi River improvement and maintenance program, are under construction near Burwood, La., contract being awarded in January, 1935, by the U. S. Engineer Office at New Orleans. The work consists of approximately 2,570 lin.ft. of creosoted timber spur dike and 5,000 sq.yd. of fascine willow mattress in the southwest pass of the river. Four bids ranged from the contract low of $117,652 to a high of $128,831. Comparison follows of the unit prices and totals of the three low bidders: (A) Lester F. Alexander Co., New Orleans, La. (contract), $117,652; (B) D. M. Picton & Co., Inc., Port Arthur, Texas, $121,974; (C) Badgett Construction Co., Memphis, Tenn., $128,793.

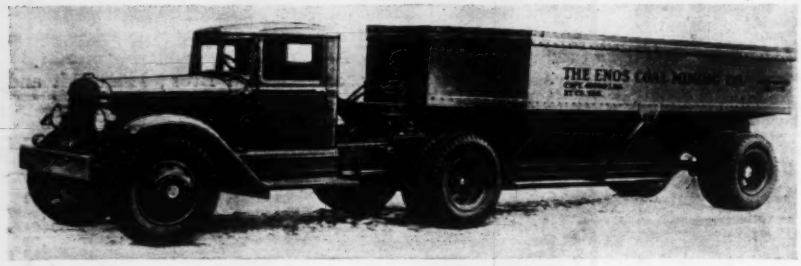
TIMBER SPUR DIKES AND WILLOW MATTRESSES

	A	B	C
1. Creosoted support piles, 35 ft.—2,835 l.f	$1.30	$1.00	$1.35
2. Creosoted support piles, 40 ft.—320 l.f	1.30	1.10	1.35
3. Creosoted support piles, 50 ft.—2,150 l.f	1.30	1.20	1.35
4. Creosoted support piles, 55 ft.—3,740 l.f	1.30	1.27	1.35
5. Creosoted support piles, 60 ft.—1,860 l.f	1.30	1.32	1.35
6. Creosoted support piles, 70 ft.—1,890 l.f	1.30	1.42	1.35
7. Creosoted support piles, 75 ft.—1,275 l.f	1.30	1.52	1.35
8. Creosoted batter piles, 45 ft.—360 l.f	1.30	1.38	1.35
9. Creosoted batter piles, 55 ft.—2,365 l.f	1.30	1.55	1.35
10. Creosoted batter piles, 65 ft.—4,420 l.f	1.30	1.75	1.35
11. Creosoted batter piles, 70 ft.—2,170 l.f	1.30	1.85	1.35
12. Creosoted batter piles, 80 ft.—2,160 l.f	1.30	2.05	1.35
13. Creosoted batter piles, 85 ft.—1,445 l.f	1.30	2.15	1.35
14. Creosoted curtain piles, 25 ft.—8,100 l.f	1.30	0.90	1.35
15. Creosoted curtain piles, 35 ft.—1,120 l.f	1.30	1.00	1.35
16. Creosoted curtain piles, 40 ft.—6,880 l.f	1.30	1.10	1.35
17. Creosoted curtain piles, 45 ft.—12,240 l.f	1.30	1.15	1.35
18. Creosoted curtain piles, 50 ft.—4,650 l.f	1.30	1.20	1.35
19. Creosoted curtain piles, 60 ft.—4,860 l.f	1.30	1.32	1.35
20. Creosoted curtain piles, 65 ft.—3,315 l.f	1.30	1.37	1.35
21. Creosoted pile walings, 61-62 ft.—4,652 l.f	1.30	1.66	1.35
22. Creosoted timber walings, 10 x 12 in., 22 to 24 ft.—19.2 M f.b.m	185.00	150.00	170.00
23. Fascine brush mattresses—5,000 sq.yd	2.95	3.80	4.50
24. Stone for mattresses—790 tons	5.95	6.00	6.00

Construction Equipment and Materials

Trailer of Large Capacity For Heavy, Bulky Materials

A line of trail cars (in 8 to 25-ton sizes) for handling coal, ore, rock, dirt or other materials of heavy weight and bulk, has been announced by the Austin-Western Road Machinery Co., Aurora, Ill. The new trail cars come in three standard body designs, including special, built-to-order constructions, and are equipped with bottom, or side dump doors that operate by air, hydraulic or mechanical controls.



Austin-Western Road Machinery Co.'s new trail car

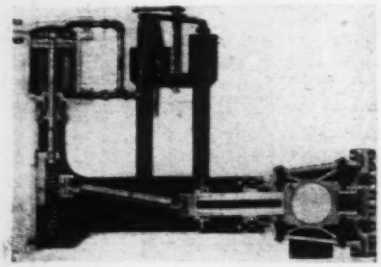
Special features include a full universal, gravity-cushioned fifth wheel for rough surface travel, generous ground clearance for easy dumping, low overall height, cab control of dumping, short turning radius, and automatic safety dumping device.

Conical Control Valve Seats Tightly When Open

A conical control valve which seats tight in open as well as closed position, and designated the Thru-Flow valve, has been announced by the Anderson Valve Corp., Pittsburgh, Pa. The valve is operated automatically by a pressure water cylinder and four-way pilot valve.

Whenever the circuit for the pump is interrupted the solenoid pilot valve is de-energized and water under pressure is admitted to the actuating cylinder. During the first 15 per cent of the cylinder stroke the gear attached to the piston rod does not rotate but remains enmeshed with a slidable segment of the rack. When this segment has moved to the limit of its travel, the gear then meshes with a stationary segment and is caused to rotate. During this initial travel the link connecting the gear with the valve stem has approached the horizontal position, moving the plug valve axially to the right, which clears the valve seat. Rotation of the gear while in contact with the stationary rack segment rotates the plug to the closed position. Further movement of the piston carries the gear to a second movable rack segment and the plug is again drawn tightly into its seat.

Automatic valve of the plug type, which seats tightly in open position

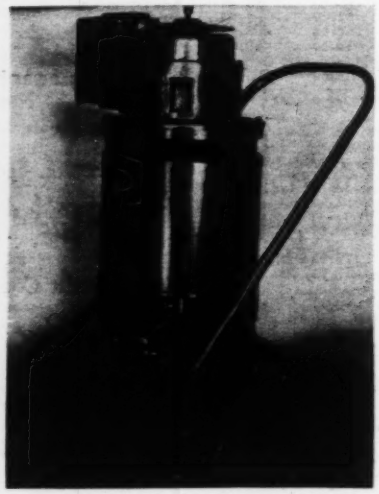


The opening of the valve is the reverse of the procedure just described.

The pilot valve may be operated by hand or locked in position to keep the valve open.

Low-Current Arc Welder For Light-Gage Metal

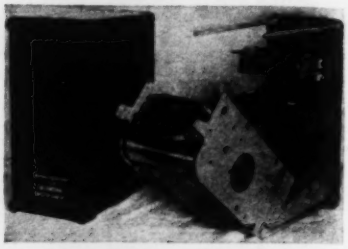
Answering the need for a low-current arc welder capable of handling lighter gage metals, the Harnischfeger Corp., Milwaukee, Wis., has just announced a new P&H-Hansen 50-ampere vertical model. The manufacturer states that the outstanding feature of the new welder, known as the W50-254, is its stable high speed arc. The self-stabilized arc is achieved through the use of an internal stabilizer winding. The machine operates on any alternating current power line, including 110 volt single phase. It requires less than 2 sq.ft. of floor space, and is 15 in. wide and 36 in. high.



New 50-amp. vertical welder for light-gage metals

New Transmitter and Recorder For Telemetering System

A duplicate position telemeter system for indicating and recording at a distance the position of mechanisms such as bridges, gates, valves or water level in water power plants, engine governor positions, or the position of any important mechanism, is announced by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The type "GH" position recorder is assembled in a rectangular case for switchboard panel mounting. An improved duplicate position type motor operates a direct acting pen which records on a strip-chart variations in the position of remotely associated mechanisms operating a motor-type transmitter.



Receiving equipment for the new type "GH" Westinghouse duplicate position telemetering system.

New Equipment in Brief

Petri Dish. Corning Glass Works, Corning, N. Y., announces an improved design of Pyrex Petri dish, which is featured by a reinforced rim to protect against chipping.

Paver. The Foote Co., Inc., Nunda, N. Y., has announced a new black-top paver featured by a two-speed cutter bar and a power cut-off. With the new cutter bar the speed may be adjusted in accordance with the density of the mix. The power cut-off permits shutting off the discharge of the mix to the road whenever necessary. A new roller lubrication device is provided to prevent material from adhering to the rollers.

Business Notes

LUKENS STEEL CO., Coatesville, Pa., announces that W. A. Hauck has been appointed assistant to the president.

ILLINOIS CORRUGATED CULVERT CO., Peoria, Ill., has been organized to fabricate and sell Toncan iron corrugated metal pipe, sectional plate pipe and arches throughout the state of Illinois, according to an announcement by F. A. Kelly, president of the Toncan Culvert Manufacturers Association. Construction of a modern culvert fabricating plant is now under way at Peoria, but pending its completion, shipments are being made from Danville.

LINK-BELT CO., Chicago, Ill., announces that William L. Hartley, heretofore manager of the Detroit office, assumes the position of manager of foundry equipment sales, with headquarters in Chicago. Harold L. Hoefman, heretofore manager of the company's Indianapolis branch, succeeds Mr. Hartley as manager of the Detroit office. Richard B. Holmes, of the St. Louis office, succeeds Mr. Hoefman and Carl A. Blomquist, of Chicago, succeeds Mr. Holmes at St. Louis.

ROME GRADER & MACHINERY CORP., Rome, N. Y., has acquired the Rome road grader business formerly owned by the Rome Manufacturing Co., Division of Revere Copper & Brass, Inc. The new organization plans to be in production about the middle of March.